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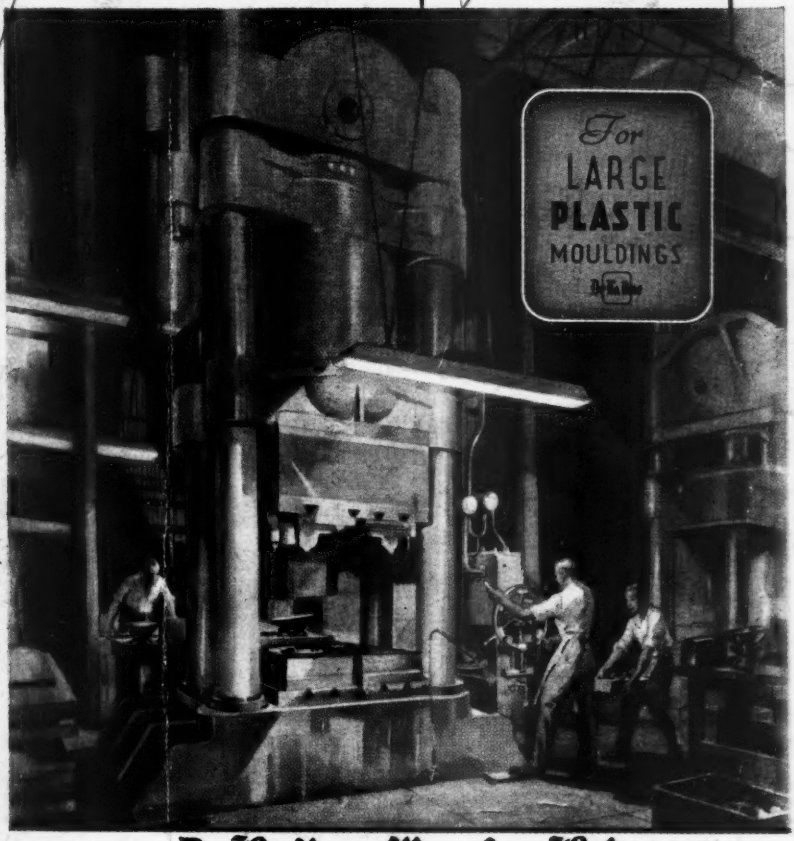

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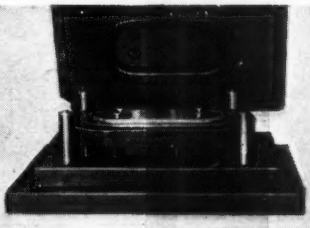

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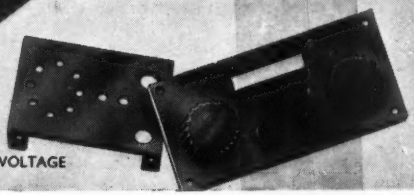

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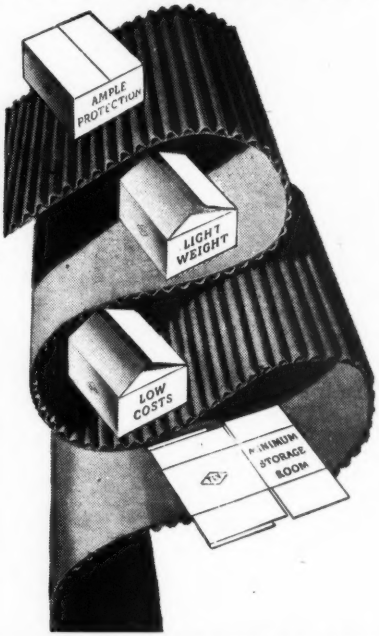

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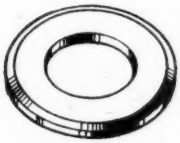

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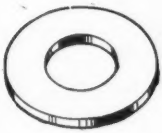

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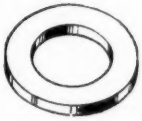

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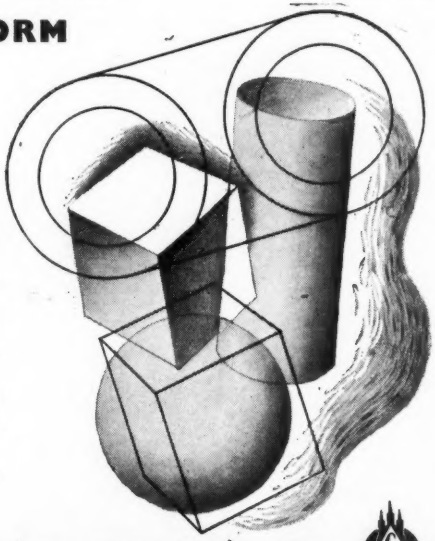

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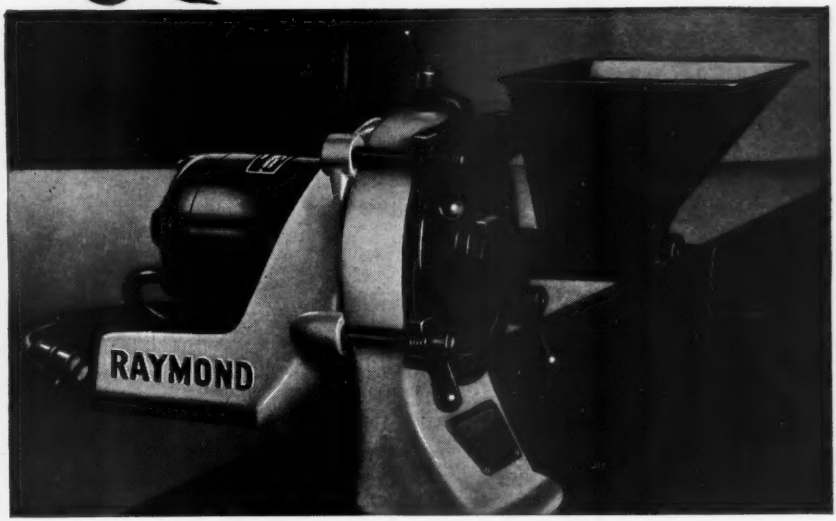

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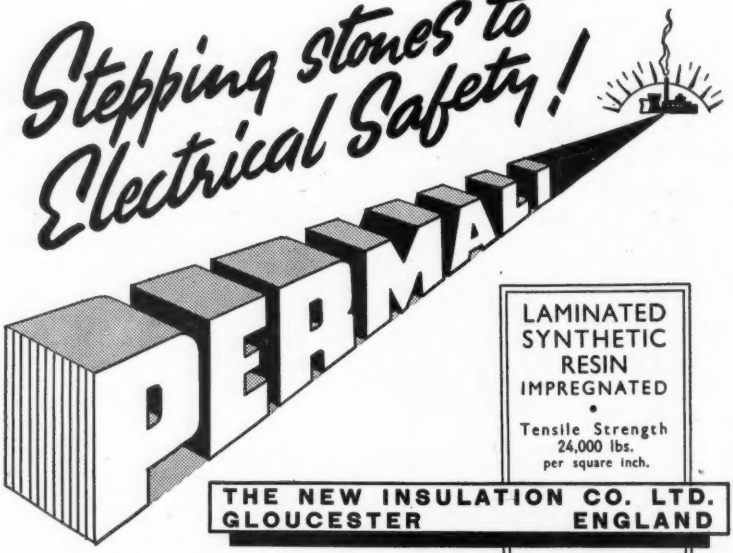

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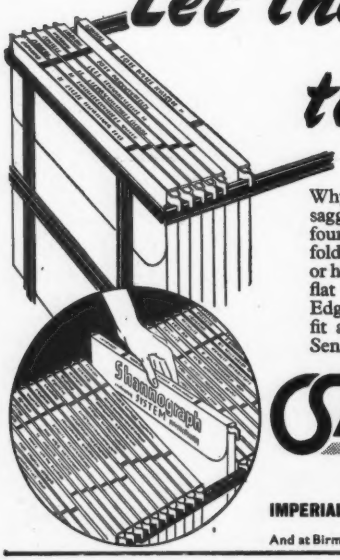

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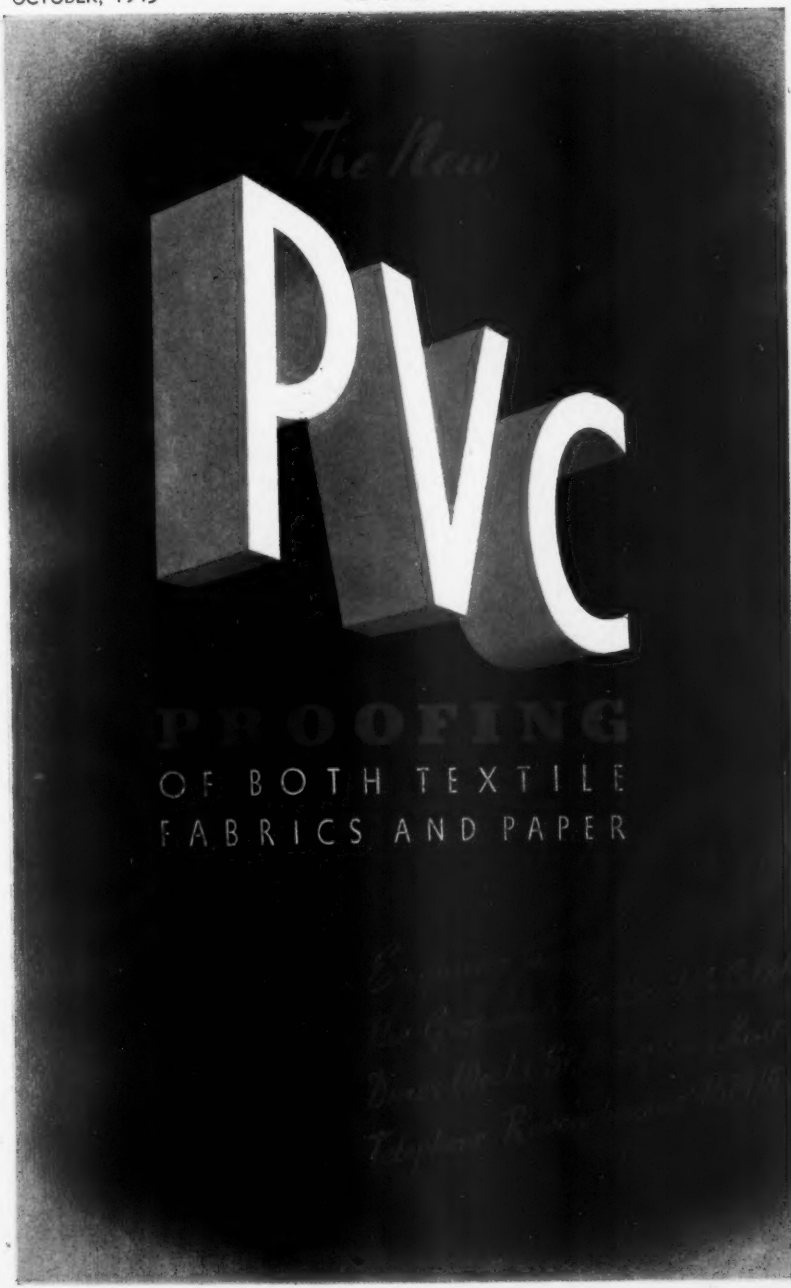
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Vol. IX. No. 101 OCTOBER, 1945

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

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NOTICES

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EDITORIALS

Front Line Plastics

THE story of plastics in war-time is gradually being revealed. Towards the end of the war driplets of news came through as components came off the secret list, but to-day secrecy is generally no longer necessary. Chairmen of producing companies are telling the stories of their work and exhibitions throughout the country are giving fascinating views of the accomplishments during the war years.

The story of our British factories is a magnificent one, of high endeavour and devotion in the face of labour and supply difficulties, often under the scourge of aerial bombardment. But the spate of mouldings and fabricated units to the ordnance centres never ceased to flow and fulfil the demands made by the logistics of war.

So much for the home front; but, quite unknown to the vast majority of workers in this country and quite independent of this vast river of production, there ran in North Africa, from 1941 onwards, a steady stream of plastic units much closer to the zones of war. Far from established factories and cut off from commercial raw materials and industrial plant, there grew up in the Middle East a source of resin moulding powders, of plastic mouldings and laminated fabrications that played no small part in the British Desert victory.

It was R.E.M.E.'s baby. By its "on the spot" replacement of broken plastic parts, by its ability to produce rapid modifications of components, by its manufacture of plastic tools, and by its ability to examine plastic breakdown under war conditions, this service from the workshops of the Royal Electrical and Mechanical Engineers is worthy of the highest praise.

The tale is now told on page 476 of this issue for the first time, and Capt. F. J. W. Bartlett, M.B.E., R.E.M.E., gives it to us as a plain and unvarnished one. He does not indicate his own part in it, which, we presume, was more than that of a mere observer.

We agree, perhaps, that it is not a story of first-class production methods, and yet, guessing faintly at some of the difficulties that must have been encountered, we are thrilled at the courage and power that lay behind the drive to solve the Army's and Royal Air Force's ad hoc plastic problems, starting from scratch and using indigenous raw materials for resin production.

Improvization indeed; but it was improvization with an epic flavour!

Exhibitions

AS we have already indicated, the end of the war has brought for our pleasure and extreme interest a number of exhibitions of plastic materials and processes which have been made and carried out during the war period. Some of them give us a thrilling view of colossal quantities of armaments in a hundred forms, of strange and wonderful new ideas for pursuing total war, and for the much more satisfactory purpose of going upon our lawful and peaceful occasions. We must congratulate the industry on the remarkable celerity with which these exhibitions have been got together in spite of somewhat pessimistic prognostications.

The first of these we have attended was that collected by Halex, Ltd., in September, at the Scouts' Hall in Larkswood Road. "Halex at War" was an inspiring collection of manufactures by a factory which was on the blackest of German black lists, as a captured and exhibited "Luftwaffe bombing target" amply showed. Most of the exhibits were of fabricated or moulded acetate, "Perspex" and "Distrene," but a good deal of work was also carried out with phenolic resins, since 2,500,000 hand-grenades were

moulded. Of the bewildering variety of objects on view the following gave an idea of the range made: de-icing tanks, cable ducts, jettison pipes, paddles for dinghies, stormproof camera covers, rope coverings (P.V.C.), shark scarers (containers containing special chemicals), fuse caps, model aircraft scanners (the largest were made at this factory), 670,000 ration packs which make a story of their own, handles for machetes for jungle warfare, 2,000,000 tennis balls for making commando boats unsinkable, formvar drums for a special job in magnesium manufacture—the tale seems unending.

Halex workers can, although they probably won't, rest on their laurels.

One of the most illuminating of exhibitions and most promising for the future industrial welfare of this country was that by Rediffusion, Ltd., at Dorland Hall, London, during September 20-28, on "Redifon Radio Heating."

Of special interest to the moulding section of our industry was a Daniels 60-ton press coupled to a ¼-kw. Redifon powder pre-heater; the press was turning out electrical mouldings, ⅝ in. thick and 7½ ins. by 9½ ins., using 2¼ lb. of powder. The latter was heated to about 110 degrees C. and the moulding was cured in about four minutes compared with a normal period of about 15 minutes. Sectioning showed the excellent through curing.

A larger R.H. generator of 5 kw. was also on view. The heating chamber is fitted with a multi-impression tray and is capable of heating 5 lb. of powder.

The glueing of wood or veneers when using synthetic resins of the phenol and urea types was shown in an excellent manner by the inclusion of the identical bench that produced 1,000 dinghy paddles per week during the war. Here a ¼-kw. generator supplies power to a jig in which paddle blade and shaft are glued together in four minutes. A larger jig showed the making of the body of a desk setting the glue in two minutes. The power is derived from a 2-kw. unit feeding 16 joints simultaneously.

Thermoplastic welding proved one of the most attractive of the exhibits. Two machines for doing this work were shown in collaboration with Diaplastics, Ltd., who had incorporated Redifon generators in them. The first was the well-known electronic sewing machine seaming two sheets of P.V.C. together by passing them between a pair of small metal rollers. One of these corresponds to the needle, being mounted on an arm similar to that of a sewing machine, and the other is immediately below it in the table.

The second was a jig welder using the Redifon R.H.7 generator to produce a tobacco pouch in two seconds, by means of a shaped jig operated by compressed air. The P.V.C. sheet, cut to size, is folded and placed in position; the jig is closed, power is switched on automatically and in two seconds the self-timer cuts out. The jig opens and the process is repeated.

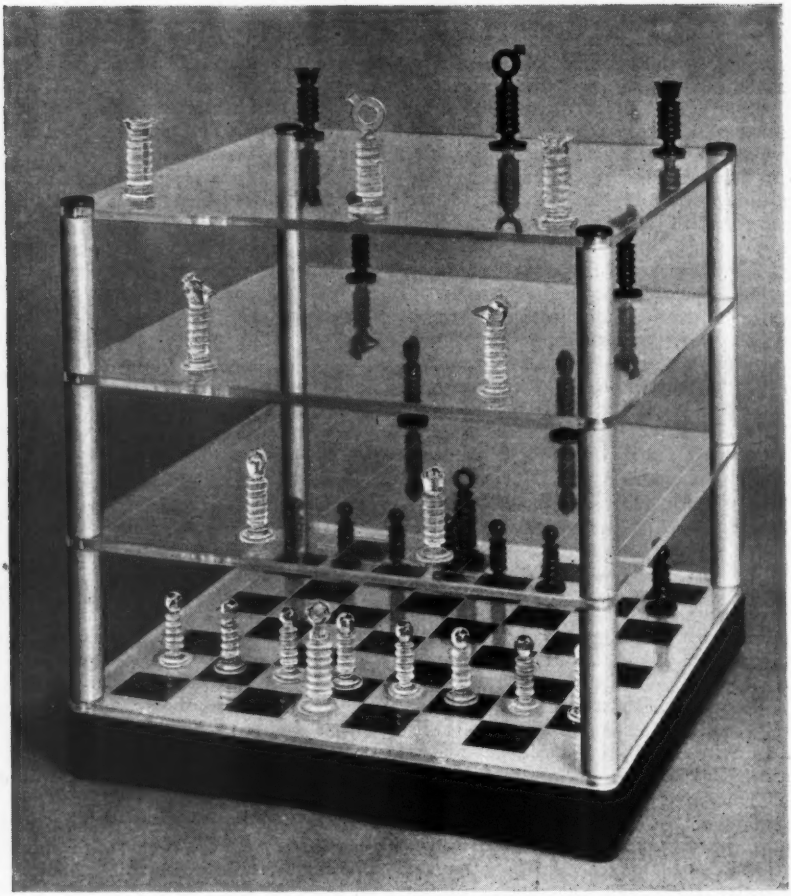
Two other exhibitions are being held while we go to press, so that we cannot yet comment on them. One is the I.C.I. "Perspex" exhibition in Birmingham, at the Chamber of Commerce, 95, New Street. There are a number of sections dealing with shop-fitting and display, jewellery, building applications (including corrugated Perspex), draining boards, kitchen equipment, lighting, etc.

Finally, we draw the attention of our readers to a novel type of exhibition organized by International Plastics, Ltd., and its three affiliated companies, Runcolite, Ltd., Plastic Spray, Ltd., and British Artificial Resin Co., Ltd., in collaboration with the Gas, Light and Coke Co. The exhibition will be held from October 16 to October 26, at 3, Vere Street, Oxford Street, W.1, and is entitled "Aluminium and Plastics in Building," an intriguing name. We have long advocated an end to material isolationism.

The object of this exhibition, which is private, is to show aluminium and plastic building components and fittings, designed for mass production. The organizers wish to emphasize the practical purpose of this exhibition in that the exhibits are available for production.

Tickets may be obtained on application to the above address.

TOTAL CHESS

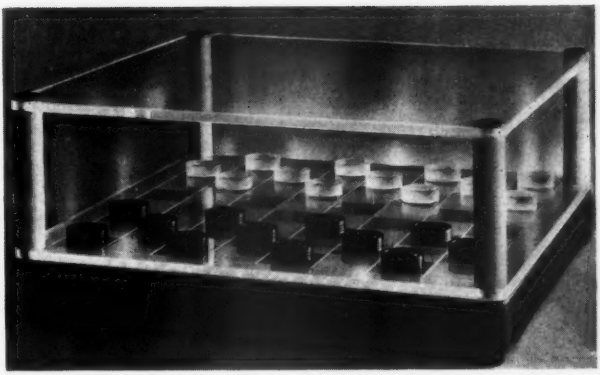


SHOWN here are views of boards for quadrivalent total chess and total draughts, according to the system devised by Charles Beatty, of Trelydan Hall, Welshpool, Mon.

The chess men shown here were made by J. Starkie Gardner, Ltd., from a special design of Ralph Lavers. They are machined from solid Perspex left respectively clear and chemically finished in a black dye; the stems of the chess men are finished matt, base and head being polished.

The board is made with standard 1½-in. squares or in club size with 2¼-in. squares.

This beautiful board, designed and constructed by J. Starkie Gardner, Ltd.,



Board and men for "total draughts," according to the system of Charles Beatty. Like the chess table shown on the preceding page, this set was designed and constructed in aluminium and Perspex by J. Starkie Gardner, Ltd.

consists, as may be seen, of a base built up of accurately machined aluminium squares alternately anodized to present a clear metallic surface and a black dyed finish. These squares are held together in an aluminium frame and are mounted on a heavy aluminium baseplate; their upper surface is covered with a sheet of clear Perspex. Superimposed above the squares are two or three sheets of heavy Perspex, accurately engraved into squares corresponding to those on the board; these subsidiary "planes" are located by means of four corner posts consisting of a throughrod passing through appropriate holes in the Perspex sheet, spacing being by means of tubular aluminium sleeves.

We understand that printed rules for these games will shortly be made available by Mr. Charles Beatty. Incidentally, they show no radical departure from those applying to normal chess.

The above illustration shows a board and men for "total draughts." Like the chess-boards, the former, built up of aluminium and Perspex, is the work of J. Starkie Gardner, Ltd. We are assured by Mr. Charles Beatty that "three-dimensional" draughts is, essentially, no more difficult to play than the normal game.

PLASTICS AND FRANCE

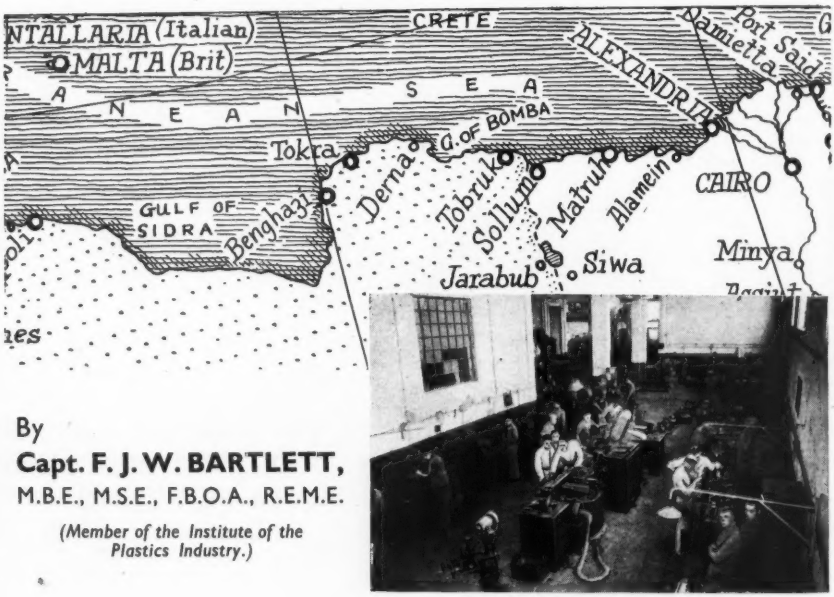
We take extreme pleasure in announcing the arrival from France of the first number of the new journal, "Plastiques," the official publication of the Centre d'Etude des Matières Plastiques. France thus begins again to take her rightful place side by side with the other great scientific nations.

The first number opens on a sad note, for it announces the death on the field of honour of the young first Director of the Centre d'Etude during the liberation of France in November, 1944. Edouard Rencker, who joined the Army as an officer in the engineers, was one of the most brilliant physicists and engineers turned out by l'Ecole Polytechnique and the Sorbonne. In the same issue is published a most informative article by Rencker on the properties of injection moulded products.

On going to press we have received a letter from Dr. Dubois, the present Director and Chief Editor of "Plastiques." He states that, in company with Mme. Gavoret, Dr-ès-sc. assistant to Professor Duclaux, of the Collège de France, he is visiting London during October to see friends and to arrange for the exchange of scientific documentation for his journal and for the Bulletin du Centre National de la Recherche Scientifique.

In welcoming these two visitors, we hope that their visit will prove fruitful and result in a close co-operation between the plastic sciences of the two countries. Readers who wish to contact the Editor should write to M. P. Dubois, Centre d'Etude des Matières Plastiques, 54, Avenue Marceau, Paris (8°).

FRONT LINE PLASTICS



By
Capt. F. J. W. BARTLETT,
M.B.E., M.S.E., F.B.O.A., R.E.M.E.

(Member of the Institute of the Plastics Industry.)

Part of Machine Shop 4, Base Workshops, R.E.M.E., M.E. Forces.

A Story of R.E.M.E.'s Work on Plastics in the N. African Campaign

The workshop under review is not put forward as an example of how a first-class plastics production plant should be initiated and developed, but only as a short history of the work done in the face of unavoidable obstacles.

Of all the thousands of engineers, civil and military, who have had to improvise and experiment to finish a job with a "dead line," most can look back and visualize "what might have been done"; but it is quite probable that, had the retrospect improvements been possible at the critical time, improvisation would not then have been necessary.

The following is, therefore, offered as an example of improvisation which it is hoped played some small part in the success of the North African campaign.

THE setting up of a Plastics Workshop by the R.A.O.C. (later R.E.M.E.) in the Middle East in early 1941 was the outcome of a G.H.Q. conference at which it was pointed out that (1) it had become difficult to forecast plastics breakages under battle conditions; (2) plastics components were arriving in the Middle East theatre already broken; and (3) local conditions sometimes called for the modification of a component.

It was suggested that a small plant be started for "stop-gap" manufacture, and that bulk demands on this plant should be avoided wherever possible. All arms of the Service were concerned, the R.A.F. being particularly interested. Local civilian firms had been requested to undertake the moulding of plastics components required by the British Army, but refused when they were informed such precision fitting parts as rotor but-

tons, distributor caps, smoke release switches and marine rotors would be required. They stated, in general, that they had little commercial powder on hand, and did not wish to speculate this on rigorous inspections which might result in a high percentage of rejected mouldings.

It was decided to try out the British Army Plastics Workshop on a small scale as an attachment to the Instrument Shop, 7 Base Workshops, Alexandria. Some experimental plastic mouldings had already been done there, so this seemed the most convenient starting point. This workshop consisted of an instrument repair shop proper, an optical manufacturing department for the production of lenses and prisms, a small machine shop, and a rough-and-ready analytical laboratory. Long before the new plastics department was ready for quantity production, the "conference" had slipped into print and there were 20,000 units on demand made up of eight completely different mouldings.

It was realized at once that some enthusiastic people rushing in demands for mouldings were unaware that costly metal moulds requiring careful design and reasonable time for tooling were needed before the plastic mouldings could be produced. This was made unpleasantly evident by the small quantities of some mouldings demanded and the absurdly early dates suggested for delivery.

The greatest problem was the inadequate quantity of commercial powder in stock and the vague possibility of fresh supplies seriously affecting development of the department. Suggestions were put forward that bituminous materials reclaimed from some types of battery boxes should be tried. For the cold moulding, such as battery lids and screw caps, this idea worked well enough, but a thermosetting material was still required for the automobile and radio components.

Every effort was made to obtain powder through the "usual channels," and the problem of supply was eventually solved by manufacturing in the workshops. The efforts in this direction cannot in any way be compared with those of a commercial enterprise. Manufacturing 10 kilograms of powder intermittently would not pay dividends, but it did keep a lot of trucks running in the Western Desert. It is amazing to recall that when Rommel was at El Alamein a plastics workshop was blissfully condensing cresols and formaldehyde to churn out rotor buttons almost on the front line. Instructions to blow up the plant if necessary did not deter the enthusiasm of the newly born plastics men; not one of them believed it would ever happen.

When the well-known materials for

Major-General W. W. Richards, C.B., C.B.E., M.C., who, as D.O.S., Middle East Forces, originated the development of "Stop-gap" production plants to speed up supply of urgent stores to the desert armies.

powder production, except formaldehyde, were no longer available locally, Major-General Richards, C.B., C.B.E., M.C., then D.O.S., Middle East, made every possible effort to get us supplies, and suggested regrinding "Perspex," of which there were large stocks in the salvage depots. A fair quantity of this was used where practicable; so was processed shellac. Both materials, of course, were

detrimental to high production because of mould cooling, and they quickly became scarce anyway. The cost of shellac rose to 50 times its pre-war price on the local market. Perspex was soon required to be sent home for reprocessing.

The scarcity of shipping space from the U.K. and U.S.A. was another vital factor which determined whether local manufacture of stores should be undertaken. If the raw materials happened to be on the spot and native labour could be employed successfully to produce the goods, time could be saved, labour eased a little at home, and the manufactures issued piecemeal as required. The articles made locally were, in many instances, not up to the commercial standard, as everyone was aware, but if they were of sufficiently high standard to operate efficiently, superficial finish could be discounted.

Manufacture of Quebracho Moulding Powder

Some time before successful attempts had been made to find a substitute for Canada balsam, an optical adhesive. A fairly powerful transparent adhesive with a relatively high melting point had been required. People were still sending along samples of resins to try, when suddenly a ton of dark brown resin-like substance turned up. On analysis, this proved to be a tannin extract and was later vouchered over, very much contaminated with sand, as Quebracho "Resin." Someone had found it in the desert and turned it over to the salvage people.

Quebracho was known to be a polyhydric phenol which reacted with formaldehyde, but there was not at that time in Egypt any technical literature on the subject. However, there were now two essential raw materials in bulk quantities, a type of phenol and formaldehyde. If they could be made to react together satisfactorily the problem of powder supply would be solved. The local agents of three well-known firms cabled the U.K. and U.S.A. for technical information regarding the manufacture of plastics moulding powders, but the results of these investigations stated, without exception, that the chemical processes involved were too complicated to be carried out in the Middle East, and that Quebracho had only been used to produce synthetic resins useful as ion-exchange agents for water purification. The first experiments with Quebracho were attempts to conserve the available cresylic acids by substituting in part with the tannin material. Experiments were carried out after routine workshop duties until, after trying many variables, suitable reactants were found which saved about 25 per cent. of the cresylic acids. The next supply of local cresols, however, was considerably adulterated, and from then on it became impossible to make any practical use of them.

While there was still a large stock of Quebracho, Mimosa was obtained locally; it was discovered, too, that there were large stocks of Velona tannin extract in and around the Middle East. Experiments carried out on Mimosa and Velona produced similar results as those with the Quebracho. Thus, the answer to the problem appeared to be—make a serviceable powder from the tannin extracts without the use of additional phenols, or cresols, or any raw material of which future supplies were doubtful. There were no "free" British soldiers available. There was little laboratory apparatus and the minimum of spare time. Putting in an hour of investigation whenever time could be found, data were gradually accumulated which eventually produced a moulding powder from the bulk materials available. It was an attempt to finish the job before the commercial powder ran out. The time was too short, however, so the losses were cut by producing from the tannins a satisfactory material to extend the commercial powder, first, by 20 per cent. and eventually increasing the percentage until the powder manufactured was 100 per cent. "home made." The absence of commercial plasticizers, apparatus, and trained men retarded the work, but enthusiasm and effort were not lacking. The R.A.O.C. organizations were searching every local avenue, and the Salvage Depot did magnificent work by investigating

any materials which were thought might be useful. Major-General Richards's encouragement and personal interest in these efforts was the real force which spurred on the men when the position appeared hopeless.

Testing Time in the Desert

About this time some thousands of cased vehicles, partially assembled, arrived. It was found that to complete the assembly required very little time when the organization to do this work got into its stride. Unfortunately, in many instances, distributor heads and rotors had been broken in transit. There were soon hundreds of vehicles in the lines only held up for two plastics components. This was a test case. It was to prove the value of the plastics shop and the amazing foresight of the D.O.S. in originating it. Portable single-impression moulds were made for the distributor heads and rotors in 24 hours and put into use at once. Production moulds were then tooled and ready for operation just as the simple mild-steel hand moulds began to lose dimensional accuracy. There was no question about the success of this venture, but it tore a gaping hole in the moulding powder stock. A short time before, a useful process had been developed by condensing the Quebracho (a polyhydric phenol) in water with formaldehyde to produce a stiff flowing binder in order to create desired properties in the fillers added to synthetic resins and bituminous materials. A small amount of flow only could be given before incorporation with the bitumen or resin proper. Employing these pre-treated fillers (paper, asbestos, scrap, cord, etc.) facilitated cold moulding and gave improved properties to this type of moulding. Eventually it was possible to use the bituminous materials for hot moulding with considerable reduction of moulding pressures and reduced baking periods. From the pre-treated filler experiences, it automatically followed that attempts should be made to add as much processed filler as possible to the commercial powder, i.e., to "extend" the small quantity of commercial powder on hand and increase the effective weight of any new powder which might be received if the quantity obtained was inadequate to meet the demands for plastics stores.

The original experiments with mechanically mixed pre-treated fillers and commercial powder were unsuccessful. Water absorption was too high and the tensile strengths far too low compared with mouldings made from straight commercial powder. It was shown by tests that the properties exhibited by correctly produced mouldings from commercial material are, as a rule, much superior, to the standards basically required for Service conditions. Therefore, if the weight of the commercial powder could be substantially increased by extension with a locally produced powder without deteriorating the properties of the mouldings beyond an accepted limit, some practical value would be realized by producing such a material. This conception appeared to be the most logical attitude towards solving the supply problem until commercial powder arrived in adequate quantities, or a locally produced plastic could be made to compete with the commercial material in moulding technique and in the properties of the finished mouldings.

Adventures in Mixing, etc.

After the unsatisfactory dry-mixing methods, attempts were made to mix the powders wet. From this method a successful routine procedure was developed. The following is the result of an early experiment.

When a 50 per cent. water solution of Quebracho is condensed with 40 per cent. formaldehyde (e.g., 100 c.c. of 50 per cent. Q. solution with 15 c.c. 40 per cent. CH_2O) and an ammonium salt added, a yellowish-brown precipitate occurs which, after collection, drying and pressing, forms a synthetic resin. This resin in the precipitate stage was designated Q/4G.1, and after the application of heat and pressure, Q/4G.2. Depending upon the conditions of manufacture, Q/4G.1 will polymerize alone during

storage, or can be retained in the first stage until pressure and/or heat are applied. All available commercial solvents were tried on Q/4G.1 and Q/4G.2, but none was successful. Mechanical mixing of this synthetic resin with a filler would not produce a good powder. The resin will not melt to a viscous condition as the phenol and cresol/formaldehydes do. This property and its insolubility made most methods of combining the resin with the filler impracticable. It has been shown on a laboratory scale that optimum conditions of dry disintegration and mixing result in a mouldable powder, but during early investigations of this method of production large-scale operations were impossible owing to lack of the necessary machinery. Although the reactions between formaldehyde and Quebracho must have been known for a long time and some use has been made of other tannins, e.g., catechu, little has been published of the processes involved. No other accounts exist of the final method of manufacture employed by the British Army Plastics Workshop in the Middle East. When it is considered that in certain countries—South Africa, for example—great quantities of cheap tannin extracts exist, it is quickly realized that the development of such plastics is not without commercial significance. Similarly, these plastics could be produced most economically in India and the Argentine.

There is still some laboratory work to be done now that greater facilities are available. The compilation of comprehensive data, e.g., calculations of the molecular weight of the synthetic resin (Q/4G), optimum conditions of manufacture, compatibility with other synthetic resins and commercial applications.

The general utility of the early powders produced in the Middle East was, unfortunately, diminished by the absence of commercial plasticizers, e.g., tricrysalphosphate, but the following method was adopted and proved most satisfactory for the " extender " type powder.

Quebracho, 48 grams to 100 c.c. of water, is dissolved at room temperature. The solution may be filtered to remove dust, etc. For every litre of this solution about 40 c.c. of 40 per cent. formaldehyde are required. Condensation may be carried out from 30 to 50 degrees C., according to the available working conditions.

Fillers of woodflour and fabrics, asbestos, flock, paper, slate-dust, etc., may be employed as with the usual phenol - formaldehyde powders. The fillers should be pretreated with lubricants, e.g., zinc stearate, light mineral oils, or sprayed with a plasticizer.

When the fillers have been satisfactorily processed they are transferred with the condensed solution to a simple dough mixer. An ammonium salt sprayed in under pressure is a convenient method of bringing about the precipitate of the synthetic resin Q/4G.1. Precipitation of the first-stage resin occurs almost at once, although this is governed by the strengths and temperatures of the solutions used. The ammonium salt may be the sulphate, chloride, nitrate, or others. Ammonium nitrate, obtained as a salvaged material from the breaking down of amatol from unserviceable shells, was principally used.

The natural colour of the contents of the dough mixer is dependent upon the colour of the fillers and the type of precipitate induced. This natural colour, before dyestuffs or pigments are added, can be controlled between light fawn and dark brown. Mixing is continued from one to six hours. The period of mixing is, of course, governed by the viscosity of the condensed solution, particle size of the filler, temperature of the mixture, and acidity requirements. Controlled acidity from the beginning to the end of the process is of great importance in producing a good powder.

The plasticizers may judiciously be added to the fillers, but it is better, if the plasticizer is water soluble, to add it to the condensation solution. With ethylene glycol (anti-freeze), which for some time was the only plasticizer available in the quantities required, it is easier and functionally superior to add it to the original

Quebracho solution. Excessive plasticization leads to "sweating" of the moulding. For an average type moulding powder 59 to 100 c.c. of ethylene glycol to 1,000 c.c. of 50 per cent. Q. solution is satisfactory.

Stock solutions for other purposes were made of Quebracho dissolved in ethylene glycol without the addition of water. When hexamethylene-tetramine is added to such a solution the product, after some weeks at room temperature, is a gel which eventually yields a similar form of synthetic as Q/4G.1.

The condensate, fillers, catalyst and plasticizers, with any other synthetic resin of the cresol or phenol type, if employed, are removed from the mixer into non-metallic trays and dried slowly. On removal from the mixer the material is a wet mud-like mass, which is formed into cakes and then powdered when dry. Moisture content control is important from a mechanical point of view.

Ball milling was principally employed to reduce the bulk factor of the finished powder. A material manufactured as above, but without a free-flowing resin to assist adhesion of the filler, can be made for the flat type of mouldings or mixed mechanically with a commercial powder to control the flow for high-walled mouldings. It was found that fully cured mouldings could be obtained in some types of Q/4G.1 powder without the addition of a separate hardener added in the dry stage. That is, full cure was obtained in the mould by heat and pressure alone. Powders of this type can be prepared for moulding at temperatures between 140-200 degrees C. with pressures of 1,000-1,500 lb. sq. in.

Comparison with Usual Phenolic Resin

The phenol-formaldehyde or cresol-formaldehyde resin of commerce will melt at from 60-100 degrees C., permitting the fillers to be thoroughly incorporated on hot rolls or in a Werner-Pfleidered type mixer-extruder. Scientific control in manufacture is essential, otherwise the synthetic resin will procure before it reaches the moulding presses.

Major E. C. W. Husen, D.Sc., of R.E.M.E., who sent some personal notes on the manufacture of commercial phenol-formaldehyde powders, stressed the vital importance of the control needed to prevent precure. Manufacturers have their own trade secrets appertaining to successful production; thus completion step by step details with comprehensive lists of the materials, temperatures, pressures, machinery, etc., employed are not published. Fundamentally, the difference between the synthetic resins produced from Quebracho, Mimosa, etc., and the commercial phenolic types (from a manufacturing point of view) is the lack of a syrupy stage, which is a very convenient time to incorporate the fillers. It was the inability of the resin to melt which prevented practical use of the synthetic resin to be made which results from the reaction of formaldehyde and Quebracho alone. The insolubility of this resin in the usual solvents also prevents its use for insulating varnishes. Brief details are given in the flow chart of the usual phenolic synthetic resins only to indicate the essential differences in the processes employed for these materials and those developed for the tannin synthetic resins. When solutions of Quebracho and formaldehyde are heated together and the reaction carried on until a solid is produced, precuring is almost unavoidable. The intermediate gel stage of the process, which gives a dark brown, jelly-like substance, can, with difficulty, be beaten into the fillers, but cures after a few hours in a dry atmosphere. No successful retarding agent was found. Using paraformaldehyde and the Quebracho powder was tried, but the precipitation process eventually evolved was simple in operation and could be done on a large scale without autoclaves or complicated steam-heated mixing rolls. The synthetic resin derivative of tannin formaldehyde is, therefore, suitable for plastic moulding powders, but without the syrup stage during processing is precluded from use as a casting resin. With some changes in processing it may be possible eventually to produce a serviceable cast-form resin with tannin-aldehydes, but the

author believes it unlikely until considerably more research work has been carried out. Successful plasticization with another resin from which non-crazing cast resins can be produced is meeting the difficulty half-way.

Sources of Tannin Raw Materials

Chief sources of raw materials are: (1) Turkey, which exports Velona; tannins in the extract are given as 48 to 66 per cent. (2) South Africa, where the tannin extract is derived from the Mimosa bark; tannin content varies between 60 to 70 per cent. (3) Argentina, where Quebracho is produced on a large scale; 66 per cent. tannin is the average content of Quebracho. There is some Mimosa in Egypt. Other countries produce on a smaller scale. Tannic acid is a raw material produced from nut galls in England and on the Continent. Pure tannic acid is not considered an economical method of producing plastics. Full details of the extraction of the tannins are given in various treatises on leather manufacture. The growing use of synthetic tannin materials may reduce the costs of the natural materials, thus leaving them available for the production of cheap utility thermosetting plastics. Manufacture of these types of plastics at the source of supply of the raw materials would appear propitious.

Extraction of the Tannins

Extraction of the tannins is carried out by infusion with boiling water; the extract is drained away, or filtered off, and allowed to dry. The material is then broken up into small cubes and dispatched in sacks. The raw material often contains adulterants in the form of soil, gums and waxes. These should be removed carefully by dissolving in water and filtering. Catechu, from which tannin plastics could be made, is insoluble in water; therefore, using alcohol as a solvent throughout the process made it an uneconomical proposition to purify large quantities, then redissolve them for the precipitation process. Gambia, Velona, Quebracho and Mimosa are all water soluble.

Preparation of Solutions

Powdering of the extract, after drying thoroughly, is undertaken in simple hammer mills with sieves incorporated. A 50 per cent. solution is then easily obtained at temperatures between 50-70 degrees C. If the solution must be filtered, a 20 per cent. solution makes the operation much simpler. If samples of the raw materials are taken from different parts of their containers, adulteration, if any, can be estimated rapidly, and the strength of the solutions and the type of filter needed planned accordingly.

A dry atmosphere without humidity is advisable for storage of the raw material. Where stocks of the purified powdered material must be held, dry storage is essential, otherwise the material will agglomerate, reducing the powdering process to a waste of time. Damp atmospheres tend to produce fungus growths. The various raw materials—Mimosa, Quebracho, etc.—show marked differences in this tendency to fungus growth. This was attributed to the sources of origin, where methods of extraction vary from crude pits attended by natives to chemical engineering processes of European origin. Water soluble or miscible anti-fungicides, or those applicable to the emulsion process, were used to stabilize the solutions.

If a continuous process is in operation, stock solutions or bulk solutions must be maintained to retain uninterrupted production. Stock solutions increase in viscosity if the solvent (here water) is allowed to evaporate. If measurements are made by the volume of the amount of extract required to go to the condensers errors will occur. It is necessary to carry out routine laboratory check tests on the percentage of solids in the solution and to protect these solutions from dust and other foreign matter. Tests should also be made to estimate the minimum amount of anti-fungicides required to prevent deterioration. Excessive amounts should not be used. Estimation of the viscosity of the solution is to protect against blocking the mixing machines and to ensure thorough incorporation of the fillers. The

design of the mixer (blades, etc.) will prevent trouble in this direction unless greatly different types of fillers are incorporated at various times in the same machine. Knowledge of the density of the mix within certain practical limits will permit estimation of mixing periods, speeds and planning of the time of commencement of the next operation of the process.

Plasticizing to Assist Flow

According to the method adopted for manufacture of the powder, a water-soluble plasticizer or an insoluble plasticizer, ethylene glycol and tricrysal phosphate respectively, are added to the Q. solution or the dry moulding powder. The percentage of ethylene glycol for a standard powder is approximately 6 per cent. of the volume of the solution.

The filler in this instance is woodflour. It was found advantageous to add all the plasticizer, if tricrysal phosphate is used, to about 5 per cent. by weight of the powder, and then add this experimentally to varying proportions of the batch until successful flow is obtained. Excessive plasticization causes " sweating " of the moulding or laminate. A fault of insufficient plasticizer in the mix is a tendency to crazing after a period of days, or even months. This is most frequent in fully cured mouldings. Plasticizing the straight Quebracho powder can be carried out with alcoholic solutions of phenolic resins or alkyds. The proportions used were in the region of 5-10 per cent. by weight of the " Qubrite " resin. The copolymerization resin, using aniline-hydrochlorideformaldehyde, is self-plasticizing. Of the commercial plasticizers incorporated on a laboratory scale, " Carbitol " citrate, glycerol, ethylene glycol, tricrysal phosphate, benzyl cinnamate, dibutyl phthalate were found satisfactory.

Some lubricants employed were light mineral oils, zinc stearate, stearic acid and glycerol monostearate.

Ingredients of the Condenser or Steam-heated Mixer

The tannin extract, suitably treated with plasticizers and anti-fungicides, is run into a jacketed vessel. Arrangements are made to heat the vessel with steam, cool it, and, if required, blow steam into the mixture. Temperatures can be maintained from 10-100 degrees C., and mixing blades, power driven, are designed to incorporate thoroughly the fillers with the condensate. An ordinary dough mixer without heating arrangements can be employed, but limits the types of moulding powders which can be produced.

Fillers

These are used to modify the properties of the plastics, which can be made heat-resistant, abrasive, shock-resistant, and of high dielectric strength according to whether asbestos flock, emery powders, chopped fabrics or mica dust fillers are incorporated with the resin. Considering woodflour as an example, this material is usually acceptable for general-purpose mouldings; the weight of the filler should be from 35-45 per cent. of the finished moulding. Ordinary sawdust may be used, but better results are obtained with woodflour of from 40-100 mesh with as little natural resin as possible. If the woodflour is to be pretreated with lubricants, the moisture content should not be more than 10 per cent. Indication of the percentage absorption of the synthetic resin by the woodflour is given by moulding samples and carrying out tensile tests, etc. The woodflour in the condenser was arranged to absorb or mix with 45 per cent. by weight of precipitate 25 minutes after adding the catalyst. Adjustments were made for the different types of fillers. Asbestos and paper were given a very high percentage of resin in one batch and a very low percentage in others. Adjustments for flow, tensile strength, etc., were made in the batch averaging machines.

For woodflour the catalyst employed was first dissolved in an overhead container attached to the condenser, with an arrangement for spraying under pressure. The period of spraying for ammonium chloride was about five minutes for 25 kg. batch. The temperature of the condenser was usually raised after this to ensure

satisfactory reaction of the mix. After 30 minutes of mixing, the wet mass is incompletely dried by evaporation of part of the water; then a plasticizing resin may be added in solution, or as a fine powder. An additional 30 minutes' mixing, during which time the acidity is noted, and the material is ready for ejecting on to wooden trays. Drying at a controlled temperature in steam-heated ovens or with infra-red lamps follows. Attention must be paid to prevent the top surfaces of the wet powder drying too rapidly with excessive heat, which may result in precuring. Drying should be carried out slowly at the commencement, say, 30 degrees C., for seven or eight hours, with an increase in the temperature after this period, and a relative decrease in time. Agitation during drying is advantageous.

The dry powder, in the form of cakes or lumps, is disintegrated in a hammer mill with a 40-mesh sieve. The material may be stored at this period or taken through to a finer mesh. If a first-class commercial-type disintegrator or Banbury-type mixer is used, additional powdered lubricants may be added. With powders capable of passing through an 80-100-mesh sieve four or five batches may be blended in a large drum or other type mixer. The characteristics of the various batches are noted from experimentally moulded discs. Ball milling or rod milling reduces the bulk of the powder. Lubricants may also be added in this operation. Paper-filled powder needs this treatment to a greater extent than wood-flour-filled material. Mechanical mixing of powders with different fillers was a common practice to control flow.

(To be continued)

THE ABRASAW

THERE are many non-metallic materials which, owing to their abrasive properties, cannot be cut economically with metal saws. Paper and fabric boards impregnated with synthetic resins; sheet ebonite, loaded ebonite and other insulating materials cause rapid wear on the saw, and the resultant finish is rough and burred.

To deal efficiently with these materials a new machine, the Abrasaw, has been introduced. The cutting medium is an abrasive wheel which permits high rates of cutting with exceptional accuracy and ensures a clean, sharp edge on the material. Dust and fumes are also eliminated from the atmosphere.

The Abrasaw comprises two complete units, the machine and the dust collector, both of which are of high-class fabricated construction.

The wheels supplied with the machine are 12-in. and 14-in. diameter, 3-32-in. wide with 2-in. hole to cut up to approximately 1-in. thick.

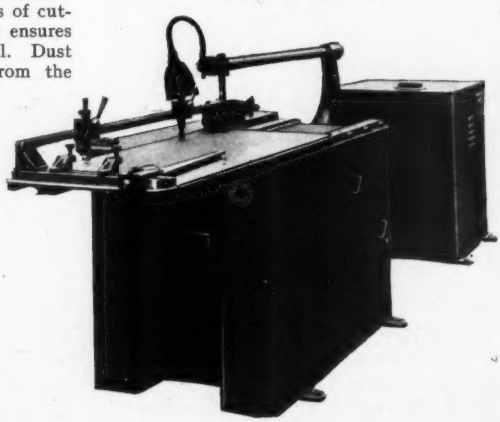
The wheel spindle is mounted on anti-friction bearings and suitable pulleys are included with the equipment to give a wheel speed of 15,000 ft. per minute.

The spindle is driven by " vee " ropes from a 10 h.p. motor which is mounted, together with the wheel spindle housing, on a pivoted cast-iron frame providing by suitable linkage vertical adjustment to the vee ropes.

The wheel spindle is of the quill type, similar to that used on grinding machines and can be withdrawn bodily from the machine. The sleeve is completely sealed and forms an oil bath for the bearings.

The top of the machine carries two cast-

(Continued on page 513)



The Microscopic Examination of Plastic Materials

Laminated Materials (continued)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

UP to the present we have dealt with the structure of what might be termed a "duplex" laminate, incorporating the two basic principles of fabrication; that is to say, curing by heat and pressure, and curing by heat alone. The structures resulting from these processes have been demonstrated, together with certain undesirable features resulting from them. The theory was advanced that a successful material for electrical purposes would be one in which occluded pockets of air or other substances of a gaseous nature were entirely absent. The homogeneity of the material would be such that the interfaces of the paper material would be in intimate contact, and the paper completely impregnated with the resin, the resultant structure consisting of the paper embedded in a continuous solid matrix or resin. It was, however, pointed out that owing to the structural nature of the fibre used in the paper, complete and uniform impregnation became very difficult, if not impossible.

These observations have been based on the use of a material made by one manufacturer, but, in general, they may be taken to apply to all laminated materials fabricated by either of the two aforementioned processes. This is illustrated by reference to Figs. 26 and 27, which are photomicrographs illustrating the two extremes of structure so developed. Fig. 26 shows a transverse section taken from a high-grade laminated phenolic sheet, produced by a well-known manufacturer, photographed at 150 diameters.

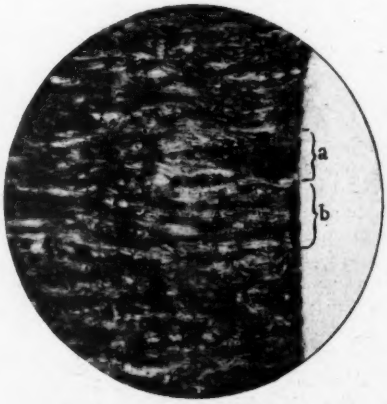


Fig. 26.—Transverse section of high-grade laminate. (Magnification: 150 diameters.)

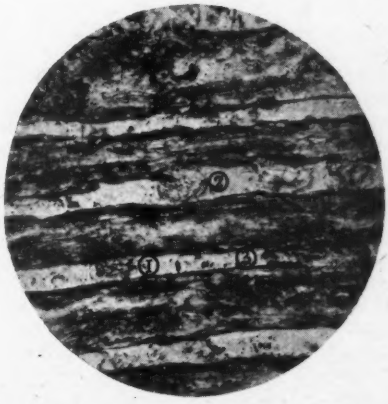


Fig. 27.—Structure of low-grade laminate. (Magnification: 150 diameters.)

This material is generally looked upon as being in the highest class of electrical laminates and is cured by heat and pressure. The illustration clearly shows how nearly the suggested ideal can be approached; the paper interfaces are so close together that the separate layers are only distinguished with difficulty. Two layers of paper are annotated at (a) and (b); at this magnification there are no air bubbles apparent, likewise there are no large separated resin masses, thus indicating the presence of tightly packed structure, which would appear to be difficult to improve, in view of the nature of the base material, and without the use of pressures in excess of those used at present.

In contrast to the compact structure shown in Fig. 26, the illustration in Fig. 27 shows the structure of a cheap, low-grade, heat-cured material. This is a photomicrograph of a portion of a transverse section through a rolled tube at 150 diameters. As can be seen, we have the structure characteristic of the heat-cured materials, although in this case the material is of a very low grade, in consequence of which the paper lamellæ stand out very clearly, revealing the presence of considerable interlamellar resin masses, in which large bubbles may be detected; 1, 2 and 3 show a few examples of the type of bubbles met with in this material, which are so large as to completely bridge the interlamellar space in which they exist. The paper in this type of material is only slightly impregnated with the resin, hence the electrical properties are poor. The size and location of the bubbles would indicate incomplete solvent removal, and possibly the presence of air which would be forced out of the dry heart of the paper.

Thus we see the structural differences in the two extreme grades of these laminated materials, the one showing a compact structure and the other an extremely open structure with a high percentage of bubbles in large resin masses.

Various suggestions have been made with a view to improving the homogeneity of a laminate material, the chief of which was the use of a base material employing solid continuous fibres. In this way may be produced a better impregnation of the base, thus leading to a finished product in which the base material would be embedded in a continuous matrix of the solid resin. Each individual filament in the material would then be entirely surrounded by resin. With regard to this point, it is the author's opinion that if the problem were viewed from the aspect of endeavouring to fill the resin with the base instead of bonding the base with the resin, then a better electrical product would result, because, after all, the resin is the medium which imparts the electrical characteristics to the material, which assumption is supported, in some measure, by the fact that all these laminated materials exhibit much better electrical characteristics when measured between the faces of a sheet than when measured between cut edges.

Although this ideal structure is very desirable, its effect on the mechanical strength of the laminate should not be overlooked, as it would appear that an homogeneous structure, such as that suggested, would be hard and brittle and thus more likely to fracture than one in which the base material was incompletely impregnated. This point is important, inasmuch as a large proportion of laminated materials, when used as electrical insulators, also have to carry not inconsiderable mechanical loads. Consideration of the problem has to be undertaken with these two factors in mind, as the tensile strength of a laminated material would apparently improve with a deterioration of the structure required for high electrical strength. As elasticity in such a structure can only be obtained when the fibres in the base are permitted to move relative to each other, at the same time allowing them to stretch by virtue of their own inherent elasticity, it will be clear that the more nearly we approach the ideal electrical structure the less likely are these characteristics to be evident.

The difficulties attendant upon completely impregnating a base material composed of cotton fibres have already

been emphasized, but we have just seen that incomplete impregnation is, to a degree, advantageous, and if the degree of impregnation could be expressed as a mathematical quantity, no doubt we should find that there was an optimum value which produced the best compromise between the electrical and mechanical characteristics of the finished material. Therefore, one could argue that, this being the case, why try to improve matters by using a base material containing solid continuous fibres with a view to obtaining perfect impregnation? It is impossible to give a definite reply to this argument owing to the lack of information on laminates made with such base materials, but, from considerations of their structure, it would appear that bases of this type, which, of course, are woven fabrics, would show a decided improvement on the cotton fabric bases, as they would allow much better impregnation and adjacent layers would be more intimately in contact due to the absence of masses of starchy dressing material, such as encountered in the cotton fabrics. The chances of the inclusion of considerable quantities of air would thus be greatly reduced; at the same time, these factors would produce a structure more closely approximating that obtained in the high-grade paper material, and, provided the basic fibre chosen had the required degree of elasticity, it would seem possible to produce a fabric-based material with the desired electrical and mechanical qualities. Indeed, it is highly probable that for any given cotton-based material a continuous fibre-based material could be produced with equal or better qualities.

The foregoing remarks have, of course, been based on the use of continuous fibres, such as regenerated cellulose, nylon and, possibly, natural silk. There are, however, figures available for a continuous fibre laminate, this latter being the glass fabric-based material. If the mechanical and electrical properties of this material are compared with those of the cotton-based paper and fabric laminates, ample support for the aforementioned theories is obtained. Thus the following figures given in Table 1 are quoted by Barron (" The Physical Behaviour and Testing of Plastics," Barron, " Plastics," June, 1944).

It is not proposed to enter into a detailed analysis of these figures, as, in the main, they speak for themselves, but consideration of one or two of the salient features will not come amiss. The outstanding feature evident throughout the table is the ***reduced range*** in the results for the continuous glass-based material as compared to the other two; in each case the results show a higher range of figures for the paper and fabric bases. It might be argued that this is merely due to the use of different grades of material, but the point of the argument is contained in the statement itself, inasmuch as the shorter range of the glass-based materials indicates a greater consistency in the microstructure of the substance, due to consistently better impregnation. This, in turn, would appear to be due to the nature of the base, which allows easier impregnation, thus more nearly approaching the theoretical homogeneous structure. This assumption is amply justified on a consideration of the figures for tensile and flexural strengths, which, in all probability, are the most important; in each case those for the glass-based material are considerably higher and accompanied

Table 1.

Material	Tensile strength, p.s.i.	Modulus of elasticity	Impact strength, ft./lb. to fracture	Compressive strength, p.s.i.	Flexural strength, p.s.i.
Phenolic laminate, paper base ..	7,000–19,000	4.0–20.0	0.3–3.8	20,000–40,000	13,000–30,000
fabric base ..	7,000–16,000	3.5–15.0	0.8–8.0	20,000–44,000	13,000–30,000
glass fabric base	14,000–20,000	10.0–20.0	5.0–6.5	40,000–50,000	20,000–30,000

by a much shorter range. From this we may conclude that the use of continuous fibre fabric-base materials, apart from producing a better product mechanically, also tends to alleviate manufacturing difficulties by facilitating the production of more consistent materials. It would also appear that control of the degree of impregnation, together with selection of the right type of base material, would facilitate the production of laminated materials with predetermined characteristics and suitable for a specific purpose. In other words, we could virtually design a laminate for a particular function.

Still using the glass fabric-based material as our comparison of solid fibre bases with cotton, a large measure of support for the use of solid fibres is shown by the moisture absorption figures for the three previously quoted types of material. These are shown in Table 2, from which it will be seen that whereas the laminates with cotton bases possess an exceedingly wide range (0.30-9.00), that for the glass fabric is only from 0.30 to 0.50 per cent. It would appear that in cases where the moisture absorption is required to be low, then the choice of a continuous solid fibre base material would be the most advantageous. These figures are quoted by Barron, who describes the method of taking them as laid down in B.S.S.771, where a disc of 50 mm. diameter by 12 mm. thick is weighed after drying and again after immersion in water for 165-170 hours at 20 degrees C.; the moisture absorption is expressed as a percentage of the weight of the dry specimen. This method is, of course, well known, but the author would venture to suggest that the percentage moisture absorption figure is really misleading, because if the thickness of the specimen is increased to, say, 2 ins., then it will be obvious that, for the same time of immersion, a very much lower figure would result, thus creating an erroneous impression of the merits of the material. Let us, therefore, examine this question of moisture absorption more closely, commencing with the mechanism of the phenomenon. The first thing we require to know is, where does the water get into the material? With regard to this, our knowledge of the micro-structure of laminated materials would lead us to suspect all cut faces as offenders, which assumption is, of course, correct. In reconsidering the structure in general, we have (for all practical purposes) an impermeable layer of resin at the mould faces; on cutting the material a face is exposed which is more or less hygroscopic according to the nature of the base material used and the curing technique adopted. As a result of this it is logical to assume that the moisture can only enter the material through these cut surfaces. This is quite simply proved by carrying out measurements on samples which have had their cut faces carefully varnished with a good moisture-resistant varnish, when it will be found that the moisture absorption of the material is considerably reduced in the case of the very low-grade materials, and becomes negligible in the higher grades.

Table 2.

Material	Moisture absorption, %
Phenolic paper laminate	0.30–9.00
Phenolic fabric laminate	0.30–9.00
Phenolic glass fabric laminate ..	0.30–0.50

So much then for the points of entry. The next point to come under consideration is the mode of entry. Here again our knowledge of the structure gives us the clue, for it will be obvious that as we have just shown that the homogeneous external layer is impervious, the only way that moisture can enter the structure of the material is by way of the base; that is to say, the cotton fibres in the one case and the glass fibres in the other.

The paths taken by the water on its entry into the material may be easily shown if samples are immersed in water containing 1 per cent. methylene blue, when the dye will be carried into the material and stain it. Thus, if a section is made the behaviour of the water will be easily seen.

Accordingly, samples of the duplex material previously discussed were thus treated, the paper based material being

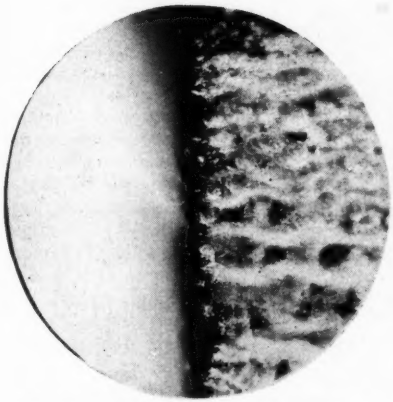


Fig. 28.—Polished longitudinal section of fabric-based laminated showing moisture absorption. (Magnification : 47 diameters.)

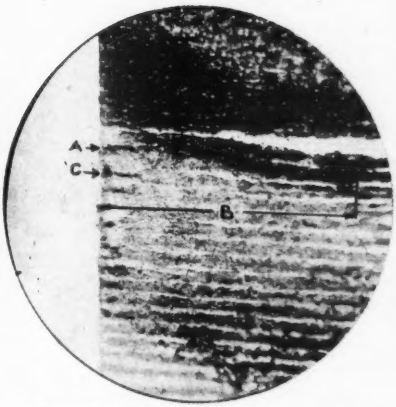


Fig. 29.—Moisture absorption into core and body portion. (Magnification : 47 diameters.)

immersed for 24 hours and the fabric-based material for 12 hours. On sectioning, the paths taken by the water were vividly shown. In Fig. 28 we see a longitudinal polished section of fabric-based material. The depth of penetration of the methylene blue solution into the fabric portion is quite easily seen.

A transparent section of the duplex paper-based material shows the effect much more clearly, as will be seen by reference to Fig. 29, which is a photomicrograph of a portion of a section at 47 diameters. A portion of the core is included, together with a part of the body portion and the bond between them. The core we know to be pressure cured and much more homogeneously than the body, in which the moisture absorption is higher. This is shown to be so in the photograph where the methylene blue can be clearly seen to have penetrated the paper layers of the body; the penetration into the core is not so apparent, being signified by a thin black line which is more easily seen in Fig. 30, this being a photomicrograph of the core portion only, at the same magnification. The great difference between the absorption of the body portion and the core is unmistakable, but the significant point in Fig. 29 is the absorption at the bond; this is shown by a deep black line at the junction of the core and body portions (A) which extends right into the material for the distance indicated by "B." This distance represents an actual penetration of about 1/25 in., and comparing this with the worst case to be seen among the paper lamellæ, that shown at "C," where we have an actual penetration of 1/200 in., the weakness of the bond is clearly shown.

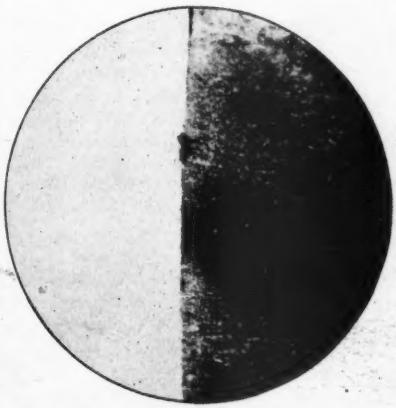


Fig. 30.—Moisture absorption of core portion. (Magnification : 47 diameters.)

Further considera-

tion of Fig. 29 shows that the methylene blue has apparently entered the structure through the paper layers, and in order to clear our minds on this point, let us look more closely at this portion of the section. Thus, Fig. 31, being a photomicrograph of the body portion at 67 diameters, clearly demonstrates the mechanism by which moisture absorption takes place. The staining only takes place in the paper layers, being entirely absent in the interlamellar resin masses. It will be noticed that there is some irregularity in the penetration of the dye, which is better shown in Fig. 32, which is a photomicrograph of the three lamellæ "A, B, and C" (Fig. 31) at 150 diameters. This illustration dispels any doubts we may be harbouring about the mode of entry of the water; at the same time it offers further proof of the impermeability of the pure resin, as shown by the absence of staining, likewise the permeability of the paper layers confirms previous statements regarding the difference of impregnation of the paper. This is further supported by examination of the core portion at 150 diameters, which is illustrated in Fig. 33. Here the penetration of the dye is very slight when compared with that for the body portion, but even so it will be seen to take place along individual cotton fibres. However, this penetration represents a moisture absorption of 0.479 per cent., taken as previously described, and is good when compared to a figure of 3.99 per cent. represented by the penetration of the body portion.

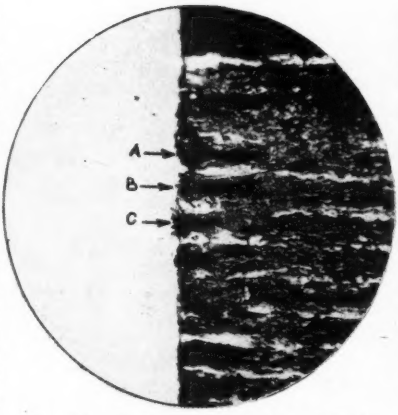


Fig. 31.—Moisture absorption of body portion. (Magnification: 67 diameters.)

Thus we see that where low moisture absorption is of primary importance, such as for electrical uses, the impregnation must be as complete as possible, and the

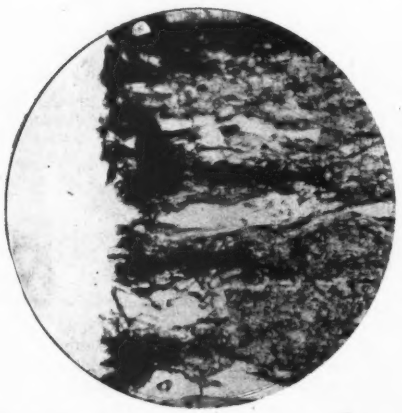


Fig. 32.—Moisture absorption of body portion. (Magnification: 150 diameters.)

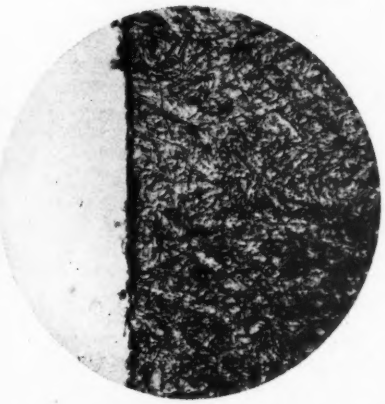


Fig. 33.—Moisture absorption of core portion. (Magnification: 150 diameters.)

base material should be composed of continuous solid filaments, preferably of a material with high moisture resistance, for we have seen that even with such a material as glass fabric, we have a moisture absorption of 0.30 to 0.50 per cent., although it must be remembered that here again the impregnation is probably anything but complete, and whereas the moisture resistance of the actual glass is negligible, that for the fabricated material exists, in all probability, by virtue of capillary attraction.

Now suppose we reconsider this problem of moisture absorption in the light of knowledge gained by the foregoing microscopic study, which showed that, for all practical purposes, the absorption due to the resin skin on mould faces of the material may be regarded as being insignificant and consequently ignored. We may therefore assume that all the moisture enters the material by way of the cut faces.

Thus, by carrying out the tests in accordance with B.S.S. 771, we have seen that the results will vary with differences in the thickness of the specimen; they will also change with varying cut surface areas, so that if the circumstances were such that the specimen had to be machined all over, in order to bring it down to the correct size, then the results would be appreciably higher, in greater or less degree, according to the area of mould face removed from the specimen. Therefore, the author would venture to suggest that this method is liable to lead to anomalous results, conveying very little information as to the true qualities of the material. Accordingly it is suggested that if the moisture absorption be expressed as the actual weight of water (in mgms.) absorbed per square inch of cut surface per 24 hours, then a much truer indication of the moisture absorption is obtained, as in this way the variable factors in the form of thickness of specimen and cut surface area are eliminated.

By way of illustrating the method, the moisture absorption of the "duplex" material may be examined, thus, on removing the core and measuring the absorption of the two major components of the rod independently, the figures shown in Table 3 were obtained.

From these figures it will be seen that the absorption of body portion is greater than that of the core in the ratio of 17:1. This will serve to show that the figures obtained by the conventional method are somewhat fallacious, because the ratio of the absorption of body portion to core in this case is only 10:1 (the actual figures being 3.27 per cent. for the body and 0.32 per cent. for the core). Obviously, this figure is capable of infinite variation according to the thickness of specimen and cut-surface area, whereas the figure obtained by taking the weight of water absorbed per square inch per 24 hours, theoretically, should not vary with the size of the specimen. The discrepancy in the figure for the whole rod is within the limits of experimental error, and considering that it was taken on fresh specimens the agreement is gratifying. These figures are the average of six in each case.

Table 3

Material	Area of Cut Surfaces (sq. ins.)	Weight of water absorbed per sq. in. for 24 hrs. (mgms.)
Core portion	0.64	20.30
Body portion	3.27	342.0
Whole rod..	3.91	368.0 (actual) 362.3 (theoretical)

These tests as described in B.S.S. 771 are, of course, for moulded materials; those applicable to laminated materials are dealt with in B.S.S. 972, 1941, wherein the maximum values are indicated by a curve, water absorption (in mgms. per standard specimen) against thickness, are referred to, the tests being made on standard specimens 1½ ins. by 1½ ins. plus or minus 0.01 in. For sheets ½ in. thick and below, the thickness of the specimen being the thickness of the sheet. Now this method of expression is certainly better than that used in B.S.S. 771, but B.S.S. 972 also instructs that all specimens over ½ in. thick be machined down to ½ in. in such

a way as to leave one mould surface intact. At first glance this would appear to be quite satisfactory, but a little thought on the matter will soon show that whereas the specimens of ½ in. thickness and below will have a steadily increasing proportion of absorbent surface, as the thickness increases, this proportion will be subjected to a sudden considerable increase (in specimens above this limiting thickness), due, of course, to the removal of 2¼ sq. ins. of impermeable material from one mould face. It must be borne in mind, however, that the absorption capacity in this direction will not be so high as that through the cut edges, as owing to the interlamellar layers of resin, the penetration will be limited to the uppermost paper layer; however, this would seem to suggest the production of misleading results.

Thus it would appear that the present method of expressing moisture absorption, in so far as these materials are concerned, leaves much to be desired, and the foregoing suggestions are offered in the hope that eventually some method (not necessarily based on the weight absorbed per unit area per unit time) will be evolved, which will convey a true position of the existing conditions. The need for this is apparent when ratios of the absorptions of body to core, resulting from the two methods, are compared. The figure 17 to 1, when compared with that obtained by the conventional method, 10 to 1, puts the comparative merits of the two materials on an entirely different level, whereas with the percentage weight figure one would be inclined to look upon the body material as being worse than the core, but not so bad as expected in view of its structure. The weight/area/time figure vividly shows the true state of affairs, demonstrating the need for homogeneity if low moisture absorption is to be achieved. Thus, once again the microscope has been shown to be of service in the examination of plastic materials, having proved that the characteristics of the finished product are dependent upon the type of structure produced. This in turn is dependent upon the materials and processing methods used in its fabrication, which would result in a higher degree of control, and predetermined characteristics.

In concluding this section on laminated materials, the author wishes to express his thanks and appreciation to Messrs. H. Clarke and Co. (Manchester), Ltd., who showed such a keen interest in this work from its inception, and who were responsible for a considerable amount of development in fabrication processes, and samples, without which the work could never have progressed so rapidly.

PLASTICS IN SOUTH AFRICA

By W. L. SPEIGHT, Cape Town

A FEW Cape Town business men are contemplating the formation of a company to manufacture fish plastics, and at the same time the plant has actually been designed and permits applied for to start at the Cape an industry for the manufacture of plastics from bamboo seaweed. Only the weed that washes up on beaches will be used, so that the crawfish industry is not harmed. After the liquid in the seaweed has been expressed the remainder will be processed into a black powder which can be used for moulding black bottle caps, buttons and similar articles. The preliminary experiments have been made by Mr. F. W. Rennie. He became interested after being concerned in the early work on making agar-agar from the wispy greenish seaweed found on the half-tide rocks at Langebaan, Saldanha Bay, and elsewhere. He experimented first with the extraction of iodine and other salts from the bamboo seaweed, but found it uneconomic. Mr. Rennie says that if the industry develops and the supply of bamboo seaweed does not keep pace he can use the same process for making a similar plastic from bagasse, the residue left after sugar cane is crushed.

World's Industry Employs Plastics

GENERAL ENGINEERING

Extruded tubing, highly elastic, and said to have exceptional resistance to plating baths in clean-solutions, has been developed by The Michigan Chrome and Chemical Co., Detroit 7, Michigan. Among the solutions in which the tube has been tested are those for copper plating, which are operated at 180 to 190 degrees F., and boiling cleansing solutions of an alkaline nature. The tube is not recommended for use in contact with trichlorethylene. The material remains tough and flexible under very adverse conditions. Its surface is smooth and glossy so that liquids drain from its surface rapidly. ("Products Finishing," 1945, August/9/110.) **Low-pressure glass fibre reinforced plastic** can be usefully applied in the manufacture of undercut, hollow and complex parts. Their application in these directions results not only in considerable economy in material but also in saving of time, tooling and labour costs. ("Automotive and Aviation Industries," 1945, August/93/42.) **Account entitled "Plastic Sandwiches" deals with properties of laminated structures of glass cloth bonded by synthetic resins.** Production techniques for the use of this material are considered. ("Scientific American," 1945/173/155.) Effect of extreme climatic conditions as regards temperature and humidity on the dimensional stability of cellulose thermoplastics has been studied by Gloor and reported in "Product Engineering," 1945/16/554. The work has a special bearing on the use of these materials in the tropics. The results are presented in tabular form and hints on design and production are given in order to obtain maximum stability. **Forming dies, foundry patterns, holding fixtures,** masking shields for plating and painting, drill jigs, etc., are now produced from cast resins. In some instances the original article is used as a pattern. ("Tool and Die Journal," 1945, August/11/108.) **Machining of glass fibre reinforced plastics** with carbide-tipped tools is discussed by Crump, of Carboloy Co., in "Tool and Die Journal," 1945, August/11/110. High production capacity is obtained with resin-bonded snagging wheels which can be operated safely at speeds up to 9,500 ft. a minute. Such wheels are said to be superior to the rubber-bonded type. ("Grits and Grinds," 1945/36/12 (No. 5).) **Machining of relatively complicated parts in resin-bonded fabric** can usefully be carried out by means of sintered carbide-tipped tools on high-speed woodworking machinery. ("Production Engineering Bulletin," 1945, August/4/327.) **Finish grinding of steel propeller** for a torpedo was conducted on an abrasive belt running round a rubber wheel fixed in turn to an aluminium wheel at a speed of 5,000 r.p.m. The rubber expands under centrifugal force and holds the abrasive belt in place. ("Machinist," 1945/89/639.) **A Symposium of plastics** is presented in the July, 1945, number of "The Tool Engineer" (new series). Manufacturing techniques are particularly discussed. Jansson, writing on tool design, outlines how a good mould should be designed and presents the necessary calculations. Other contributions in the symposium illustrate trends in the construction of modern presses, plant layout and material flow. Some of the aspects and phases discussed have hitherto not been adequately treated in the literature. **General properties and uses of moulded plastics** are considered by DuBois in "Machine Design," 1945, February, page 171. A series of tables gives the

general properties and uses for plastic materials suitable for moulding, materials being identified by type of resin and filler used. A list is supplied of trade names and manufacturers. **Internal threads in plastic materials** have been subjected to exhaustive discussion and analysis by Thum and Boden in a past issue of V.D.I. Zeit. In particular attention is drawn to the statement that all plastic materials exhibit creep under load even at room temperature, and screw combinations employing plastic nuts are incapable of maintaining appreciable pressures for any prolonged period. In special cases a metal sheath can be fitted to the outside of the nut preventing distortion and increasing thread resistance. **Hot-forming of phenolic laminates** is considered by Guhl, of the Westinghouse Electric and Manufacturing Co., in "Mech. Eng.," 1945, March, page 175. The author gives time viscosity curves for several phenolic laminate resins and it is noted that pliability at elevated temperatures has been found to be a means towards reshaping the resin, even in its full cured condition. Hot forming of laminates employs some distortion at elevated temperatures, but such distortion under load at working temperature must be of a very low order if the material is to be serviceable. Deep drawing qualities of laminates have been developed which, according to the author, approach soft aluminium in properties.

ELECTRICAL

Switching transformer in induction heating machines is assembled in a high-impact phenolic. The core assembly of the transformer is composed of four parts, terminal assembly being built up of three parts. Operation is by air pressure, and slight impact is caused in opening and closing the circuit. ("Product Engineering," 1945, August/16/521.) **Styramic HT,** supplied by Monsanto, is said to maintain form and mechanical properties at relatively high temperatures and yet at the same time be readily amenable to moulding technique. It combines heat resistance (up to 236 degrees F.) with high insulating efficiency. ("Product Engineering," 1945, August/16/573.) **Valuable information on the silicone resins** is contained in "Oil and Gas Journal," 1945, February, page 90. Silicone resins reinforced with glass give insulating materials which are practically indestructible by heat. Liquid silicones are obtainable with boiling points up to 392 degrees F. and with freezing points as low as – 158 degrees F. For lubricating greases in substratosphere flying, such products would seem to offer good practical application. For insulating wireless and radar equipment they permit operations hitherto considered impossible. Electric motors insulated with silicone products, and transformers similarly insulated, may be run under very high speeds up to abnormally high temperatures without forced cooling. Silicones are inert to most corrosive agents.

MISCELLANEOUS

Variable buoyancy fishing floats have provided a novel use for plastics. The float is in two colours, Chinese red above the water line and transparent green below. The device consists of five parts; locking plunger and float housing are cellulose acetate injection mouldings, the buoyancy chamber being of standard acetate. The line-locking plunger can be rendered inactive when it is desired to cast the float. ("Product Engineering," 1945, August/16/527.) **Test procedures for comparing the static and dynamic characteristics of natural synthetic rubbers** are described in a well-illustrated article in "Product Engineering," 1945, August/16/541. Hysteresis and damping characteristics are discussed, typical test results being presented in graphical form. It is observed that tech-

nical information upon which this account is based was supplied by Chayne and Muller, of Buick Motor Division, General Motors, Ltd. **A survey of modern surface coatings and post-war synthetic finishes** has recently been made by Taylor and reported in "Inst. Prod. Engineers Journal," 1945/24/245. Most modern compositions have been considered and their properties carefully compared. Assistance in the survey was provided by numerous concerns and independent authorities. **A survey on laminated plastics,** in "Engineering Materials," 1945, August/3/141, deals with the following recent developments: post-forming of laminated sheet, sheet with inorganic fibrous laminæ, transparent and multi-coloured laminates, wire reinforced materials and track-resisting surfaces. The same issue contains an account by Paterson referring to the advantages of plastics in the post-war automobile industry; plastic bodywork is in particular discussed. **Research by Dart and Guth,** reported in "J. Chem. Phys.," 1945, January, page 28, showed that on rapid stretching Butyl rubbers exhibit an initial cooling effect, which at a definite point passes into a heating effect. The authors describe experimental apparatus and discuss conclusions they draw from the results of their work. **Effect of synthetic resins on cellulose and protein fibres** is considered by Powers in "Industrial and Engineering Chem." (Industrial Edition), 1945, February, page 188. When cellulose fibres are impregnated with resin-forming solutions of unpolymerized urea-formaldehyde, melamine-formaldehyde, or phenol-formaldehyde, such resin formers have little effect on the properties of the fibres until they are cured or polymerized within the fibre. It is said that there is evidence to show that the resin is uniformly distributed throughout the fibre and may in certain cases actually react with the cellulose. Low concentrations of the resins formed within the fibre have pronounced effects on the physical properties, especially elongation, elasticity, wet strength, capacity for water absorption, resilience and dyeing. A new method of determining the degree of polymerization has been developed. It is shown that wool and protein fibres may be impregnated with resin-forming solutions; there is no evidence, however, that such solutions react with the wool protein. The medium in which the forming materials are applied has a pronounced effect on the properties obtained and it is shown that fibre swelling is necessary to ensure thorough penetration. **Statistical theory and Brownian motion** of long-chain molecules is studied exhaustively by Sadron in "Industries des Plastiques," Vol. 1, No. 1, April, 1945, page 2. In particular the study considers the specific viscosity of very dilute solutions of monomers; calculated values conform well to those established in actual practice. In the same issue of this journal Rencker considers the **properties of injection mouldings in thermoplastic.** Evaluation of moulding powders is considered and the author presents a table of mechanical properties applying to injection mouldings in various proprietary brands of polystyrene, polymethyl methacrylate, polyvinyl chloride, and the polyamide resins. **Plastic-material welding device** is described under Canadian Patent No. 429,555 in the Canadian Patent Office Record for August 21, 1945, page 2275. The welding process is a mechanical one depending on the use of a specially formed tool made of a material of good heat conductivity. In the same issue of this journal, under Patent No. 429,552, is described a method for participating in situ on fibres of a textile, a synthetic linear polyamide. The bulk of the patent concerns chiefly the **preparation of a dispersion of the resin.** The **properties of plasticity and elasticity in relationship to the vulcanizing process** are discussed by Denivelle in "Industries des Plastiques," Vol. 1, No. 1, April, 1945, page 16. After the theoretical consideration of the mechanics of the transition from the liquid to the solid state, properties associated with high polymers in the solid amorphous state are considered. The mechanical properties of the rubbers are then examined in the light of the conclusions arrived at by numerous investigators.

Recent Progress in the Welding of Thermoplastics

By G. HAIM

DEVELOPMENTS in the welding of plastics from the early stages were reviewed in this journal last year.[1, 2] In the meantime a wealth of published information has become available, and it appeared to be a useful task to collect these latest publications in some classified form, in order to bring the previously mentioned reviews up to date.

It was found impossible to keep to the scheme previously followed, according to which a classification was made into gas welding and high-frequency welding processes, as in many cases overlapping takes place; the arrangement of the present review is, therefore, not entirely logical but allows for the grouping of related subjects and processes.

Gas Welding of Plastics

Most of the more recent information concerns appliances and devices used for this purpose.

D.R.P. 729,311 by Mayer and Ufer describes a torch for welding thermoplastics. Compressed oxygen or compressed air is mixed with a combustible gas and the mixture is burnt in a nozzle system using a catalyst. Other devices for a similar purpose are shown in D.R.G.M. 1,521,276 and D.R.G.M. 1,526,472.

D.R.P. 739,340 for joining of building elements made from thermoplastics mentions Hennings as the inventor, and judging from the available abstract it seems to be identical with British Patent Application 11,339, which became void owing to the outbreak of war. This British Patent Application discloses a gas-welding process for thermoplastics (mainly on P.V.C. basis) using filler rods of the same or similar composition.

Lindh and Phillipps, the inventors of U.S.A. Patent 2,367,725, describe a method for the joining of thermoplastic materials which resembles the above-mentioned German gas-welding process in its principles. Its main application appears to be the joining of films or thin sheets of Saran and Vinylite. Such sheets are placed together with abutting edges and a strip of the same or similar material laid on top. A stream of hot gas is simultaneously directed against the underside of this strip and also over the surface of the two sheets to be joined. This softens the plastic material sufficiently, and subsequent pressure applied by rollers effects the welding.

A more elaborate apparatus serving the same purposes, also invented by Phillipps, is disclosed in U.S.A. Patent 2,372,737, the main improvement being a torch moving on rollers so that the distance between nozzle orifice and workpiece remains constant. Furthermore, the overlapping strip

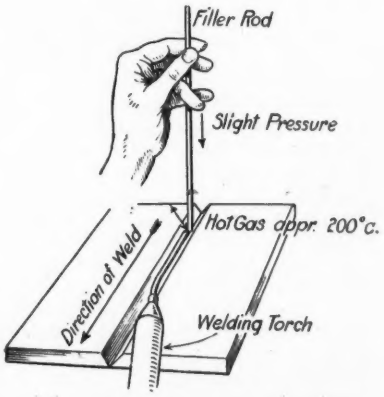


Fig. 1.—Method of feeding the filler rod in the hot gas welding process.

runs through a guiding slot, thus permitting deposition at the proper place. Another pair of follow-up rollers, also mounted on the torch, provides the subsequent pressure required for the consolidation of the joint.

An article which was originally published in "Autogene Metallbearbeitung"[3] (not yet available in this country) was reviewed in abstract form in "Kunststoffe"[4] and deals with the gas welding of P.V.C. A few details of this abstract are quoted verbatim as they may help newcomers to this technique.

". . . . Bevelling is necessary whenever the thickness of the material exceeds 1 millimetre. One-sided fillet welds should be avoided in favour of double-sided ones. Filler rods should be truly circular, as this permits more uniform softening and heating than is the case with square sections."

The proper welding technique and the way of feeding the filler rod are illustrated in Fig 1. It is most essential to feed the wire vertically, otherwise cracks or fissures may occur. The direction of the nozzle should also be noted as this is very important in order to obtain successful welds. The angle between nozzle and workpiece is of influence, a steeper angle being required for thicker sheets. Burning or over-heating must be avoided.

Not strictly a gas-welding process, but closely related, is a method of welding polythene described in Br.P. 567,360 by Du Pont de Nemours.

Thin films of polythene are placed together and their contiguous edges sealed by applying a fine-tipped flame. It is claimed that no deterioration of the polythene takes place when proper care is taken. This process can be applied successfully to the moisture-proof packing of articles. Grades of polythene which can be used are somewhat limited, it being mentioned that the molecular weight of the materials should be above 6,000 and preferably higher than 10,000.

High-frequency Welding of Plastics

In his paper on high-frequency heating, Warburton Brown[5] gives a general description of the basic principles involved and then deals briefly with their application to high-frequency welding of plastics.

Zade[6] discusses the design of electrodes used in high-frequency welding and describes a device useful for investigations of electric field distribution.

Jarrard describes improvements in electrode design in Br.P. 559,659, and discloses a method for the formation of flexible joints between rigid parts in Br.P. 560,687. The sealing of metal ferrules to plastic tubes is referred to in another patent by the same inventor (Br.P. 560,688).

Cable repairs by means of high-frequency heating are the subject of Br.P. 561,162 by Walton, Quayle and Jones, of British Insulated Cables, Ltd.

How to overcome the difficulties when sealing dielectric workpieces of non-uniform cross-sections is shown in U.S.P. 2,370,624 by Gillespie.

"Sewing Machines"

The first attempts to join plastic foils were made using conventional sewing machines. It was, however, very soon found that this technique could not be applied satisfactorily; the main application for joining such materials being for waterproof garments, protective clothing, etc., where absolute impermeability to gas and moisture is essential. Stitching P.V.C. or other plastics not only weakens the material, but also has the disadvantage that wherever holes are made they cannot be entirely filled by the thread. The space left allows water or gas to pass through and thus defeats the purpose of producing a waterproof joint. In the case of textiles the thread increases in volume when moistened and the textile itself swells, thus making the joint watertight, whereas in the case of plastic materials only the thread swells.

Other methods of joining were therefore tried; the approach to the problem was somewhat different in this country and in America from the one tried by the Germans. The German method being older, is described first.

Heated rollers applied under pressure can, under suitable conditions, effect a

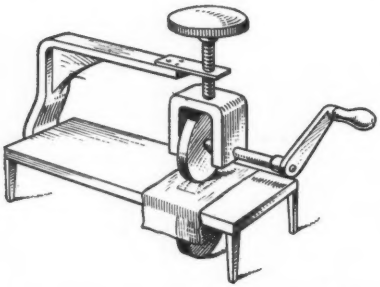


Fig. 2.—Electrically heated rollers for welding sheet. Note spring-loaded roller.

perfect seal between thermoplastic sheets, provided the material is not too highly plasticized and the speed of the rollers corresponds to the flow of the material. Other means of heating used are heated wedges or tongs inserted between the sheets to be joined. Makers of sewing machines like Pfaff perfected this method, and it was used to a considerable extent for war-like purposes such as gas capes, raincoats, hospital sheeting, etc. It is of considerable interest to learn that the reasons for developing this technique were not solely the necessity for finding a substitute for rubber or rubberized materials, but also the urgency to save thread. A very comprehensive article dealing with the welding of plastic films and foils is the one by Zeidler and Schiltzer[7] pointing out the disadvantages of using the conventional sewing machine and explaining the failure of glueing or sticking methods. The rather crude apparatus for the welding of plastics by means of electrically heated rollers shown in this paper is reproduced in Fig. 2. To prevent the sticking of the plastic to the heated rollers a foil of aluminium or " Cellophane " is inserted between the plastic and the metal and can be removed after the joint has been perfected.

An interesting application of the new technique is also mentioned in this paper, although it cannot be called a welding process proper. In order to mend worn jute bags the faulty material is cut out as far as necessary, a patch of new jute inserted and a piece of P.V.C. of slightly larger dimension placed over the patch and the surrounding area of the original material. A joint is then made between P.V.C. and jute, using heat and pressure, and it is claimed that a bag mended by this method is at least as strong as a new one. A photograph showing a similarly mended patch is shown in Fig. 3. It is, however, doubtful whether this technique would have an application in this country as new bags are probably so cheap under peace-time conditions that the repair of worn ones is unnecessary.

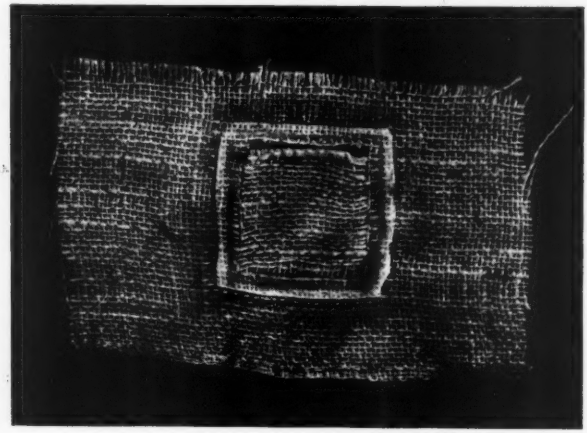


Fig. 3.—Patching of torn jute with P.V.C. sheet.

The views in this paper did not remain entirely unopposed. Kollek and Sirot[8] point out that most of the work described by Zeidler and Schiltzer can hardly be called "welding," and give their own definition of what should be regarded as "welding."

As this is a very precise and convenient definition it is cited herewith in full.

"Welding is a process during which parts of the same composition or of very similar behaviour are united by virtue of heat without adding any dissimilar material for effecting such joints.

"When even such a dissimilar material is interposed, irrespective of the temperature used, such a process should be classified as bonding."

Kollek and Sirot then discuss in detail the influence of plasticizers on the weldability and the effects of the softening range.

Regarding "sewing machines," these authors do not favour the heated-roller type and recommend machines of the heated-wedge principle.

A description of production methods for the welding of plasticized foils of P.V.C. is given in the paper, "Welding Instead of Sewing," by Heimann and Schenkengel.[9]

Some other type of heated-wedge machine is described in "Chemische Technik,"[10] where it is mentioned that the wedge can be pivoted so that it can be swung into position. Small rolls are employed to feed the material through the machine and to provide the necessary pressure. A new type of thermoplastic, Guttasyn (the basis of which is P.V.C.), can be welded on this machine, and the applications mentioned are packing of explosive charges, medical supplies and protective clothing.

It should be noted that the German inventors not only tried to protect the equipment used for this process, but also endeavoured to get some kind of monopoly for the idea of producing threadless seams (D.R.G.M. 1,483,329 and Swiss Patent 161,620). These, however, are not the only patents covering the field, and the following also relate to this subject: D.R.G.M. 1,521,318 and D.R.P. Application P.83,655, the latter referring to a machine for joining sheets of thermoplastics.

Developments in this country and in America proceeded along different lines. Considerable progress had been made in other fields using the newly developed technique of high-frequency heating, and it was, therefore, an obvious solution to extend its use to this purpose. Electronic sewing machines were brought out at practically the same time by the Arc Manufacturing Co., Ltd., and by the Radio Corporation of America, both firms working on more or less the same principles. The Arc Manufacturing Co. machine was described by Barnes[11, 12] and also by Zade.[6] A short description of the R.C.A. machine is given in "Modern Packaging."[13]

Shortly afterwards the sewing machine developed by Richardson and Allen was described in "Electronics."[14] The remarkable claim is made that this machine could weld 35 ft. per minute (compared with the 5 or 6 ft. per minute of the two machines already mentioned), but it is also stated that the machine was not yet ready for distribution. Mitchell[15] discussed later the sewing machine developed jointly by Murphy Radio, Ltd., and Herts Pharmaceuticals, Ltd., which, however, does not differ a great deal from the other types. It is stated that the Murphy machine works better when using frequencies between 60 and 100 megacycles instead of the 50 or so megacycles used for the other machines. Further details of the Murphy machine are given in the "Murphy News"[16, 17] and in the "Wireless World."[18]

Summarizing, it can be said that none of these machines has yet found a large-scale industrial use; this might to a certain extent be due to the fact that most of the plastics developed so far are not too suitable for the new technique, especially when varying in thickness or non-uniform in composition.

Spot Welding Processes and Devices

The fact that thermoplastics could be spot welded had been known for a considerable time, and the first application

was attaching straps to plastic aprons and protective clothing. This was done by means of heated tongs or pliers, and a typical apparatus is shown in the literature[7] tabulated on page 503. High-frequency heating applied to this purpose is an obvious improvement. Conventional spot welders, if suitably modified, can be used.

Br. P. 565,592 and the corresponding U.S.A. Patent 2,354,714, by the Budd Wheel Co., describe spot welding of thermoplastics by means of high-frequency currents, and particular attention should be drawn to the rather strange claim made that in addition to thermoplastics, thermosetting materials, too, can be welded, provided depolymerization is brought about first by applying ultrasonic waves. This is done in order to break down the resin in its thermoset stage; by using high-frequency heating, softening and subsequent polymerization are again achieved. Unfortunately, no further details are given in the Patent Specification.

The Murphy High-frequency Spot-welder is mentioned in the paper by Mitchell[15] already cited and in the "Murphy News."[19] Besides ordinary spot welds, comparatively short seams up to 8 ins. can also be produced on this machine by inserting flat metal electrodes.

Further devices for spot welding are the Pye spot welding gun,[20, 21] which, although developed for the purpose of tack welding of plywood, could certainly be used for the spot welding of plastics; an oscillator of approximately 100 watts at 170 megacycles is built into a rather compact portable unit.

Plastic bonding by means of the cycle-weld process is mentioned in "Aircraft Production."[22] This is reported here only because under certain conditions high-frequency spot welding guns may be used for this process.

Other Welding Processes

Welding of acrylic resins by means of heated platens inserted into jigs of a rather complicated nature is discussed by Stephen,[23] and it is almost certain that this technique might find useful application for some types of P.V.C. and vinylide chloride.

A method of joining plastic tubing to glass mainly for use in chemical laboratories is described by Kieselbach.[24] The glass tubing is drawn out gradually, and cut off when its outside diameter is slightly smaller than the inside diameter of the plastic tube. The tapered end is then carefully reheated and pushed into the plastic tube. Such a joint is leak-proof, and preferable to metal connections where corrosion resistance is important.

Welding of Plastics for Packaging

The most interesting paper on this subject was recently published by Zade and Barnes,[25] who describe a wide variety of machines used for the purpose, and clearly demonstrate the possibilities of high-frequency sealing of plastics for moistureproof packing of goods to be sent to tropical countries.

U.S.A. Patent 2,343,117, by Vincent, refers to the heat sealing of rubber hydrochloride by means of two electrically heated elements, and U.S.A. Patent 2,364,870, by Otto, indicates the use of welding or sealing of plastics by electrically heated plates for the production of laminated articles, such as holders for identity cards, showcards, labels, etc. The closing of cellophane bags for aircraft rivets is described in an illustrated article in "Iron Age."[26] Finally, reference is made to U.S.A. Patent 2,372,406, by Treneer, for the heat sealing of pellets or tablets of foodstuffs into sheets of pliofilm or similar thermoplastics.

Lining of Tanks and Reservoirs Used by the Chemical Industry

All the literature available on this subject was found in German papers, the materials used being Vinidur or Oppanol. A very extensive article in this field is the one by Sirot,[27] and the reader unable to follow the German text might find it useful to study the English abstract which is given in "Plastics."[28] It would be

beyond the scope of this review to go into the details of this process. It should only be mentioned that after bonding of the P.V.C. to the internal walls of the tank or container has been achieved by means of cements or glues, welding by means of heated tools or hot gas torches is carried out so as to weld together the edges of the plastic films.

Welding of Vinidur for inserts of tanks used for galvanizing plants is indicated in a paper by Niehus and Ruder[29] abstracted in "Kunststoffe."[30]

Training of Welders and Testing of Welded Joints

The teaching of welding thermoplastics is discussed in a paper by Krannich,[31] and it seems that considerable trouble was encountered in the first few years after introducing the new art. I.G. Farbenindustrie, the chief promoters of the welding of plastics in Germany, therefore took steps to prevent the reoccurrence of these difficulties by ensuring that material was only sold to users who had trained welders. They also collaborated in the establishment of training centres, where this new technique was demonstrated. A new class of workman was thus created—the plastics craftsman. The following five types of training classes were formed:—

(1) A basic training class for the plastics craftsman; (2) a course for the more advanced welder; (3) a course for the installation of transparent pipes; (4) a class for the lining of tanks, reservoirs, etc.; and (5) a training course for the building industry.

Some further information may be obtained from a book by the same author[32] published in 1943 in Germany and reprinted in America.

Standards for the welding of plastics have been established. They deal not only with the technique as such, but also with testing methods (V.D.I. 2,007[33]).

Microscopic examinations of welded seams and joints, using colour photography, are described in two papers by Haupt.[34, 35]

This list of references could be extended, but papers dealing with the welding of plastics in a general way, and presenting little that is new, have been omitted.

British Patents

G.W.=gas welding. H.F.=high-frequency welding. H.T.=heated tool welding.

No.	Inventor	Subject-matter	G.W.	H.F.	H.T.
559,014	Jarrard and Payne	Terminal joints for electric cable with plastic sheath and jigs therefor	—	X	—
559,111	Wingfoot Corp.	Improvements in and relating to heat-sealing rubber hydrochloride surfaces	—	X	—
559,657	Jarrard	Improvements in the welding of thermoplastic bodies	—	X	—
560,088	Jarrard, Payne and Barden	Securing thermoplastic tubes to metal ferrules	—	X	—
561,162	Br. Ins. Cables: Walton, Quayle and Jones	Making of joints, terminations or repair to electric cables	—	X	—
565,592	Budd Wheel Comp.	Method and apparatus for bonding thermoplastic or thermosetting materials	—	X	—
567,360	Du Pont de Nemours	Welding of ethylene polymer articles	X	—	—
568,065	Goldstaub	Method of jointing plastic tubes	—	—	X
569,481	Haim and Zade	Terminal joints for electric cable with plastic sheath	—	X	—
570,128	I.C.I.: Child and Stephens	Improvements in or relating to the packaging of articles	—	X	X
570,451	I.C.I.: Child and Stephens	Packaging of materials	—	X	X

German Patents.

No. (D.R.P.)	Inventor	Subject-matter	G.W.	H.F.	H.T.
729,311	I.G. Farben Industrie: Meyer and Ufer	Welding torch for plastic welding	X	—	—
739,340	I.G. Farben Industrie: Henning	Joining of constructional parts made of thermoplastics	X	—	—
83,655	Pfaff and Eckhard	Machine for the continuous joining of thermoplastic sheets	—	—	X
(D.R.G.M.) 1,483,329	Waentig	Apparatus for the welding of thermoplastic sheets	—	—	X
1,521,276	Dynamit (Troisdorf)	Apparatus for welding thermoplastics	?	—	?
1,521,318	Klepper-Werke	Joint between foldable sheets of thermoplastics	?	—	?
1,526,472	Hagen, A. G.	Device for the welding of plastics	?	—	?
38,133	Schiltzer	Method for the production of threadless seams	—	—	X

Attention is drawn to the fact that only the first three references concern patentable inventions (D.R.P.), whereas all the others classified under D.R.G.M. refer to designs. Nos. 83,655 and 38,133 are the original application numbers; no further reference has been found so far to indicate that these applications had been accepted. None of the German patent or design specifications is at present available in this country.

U.S. Patents.

No.	Inventor	Subject-matter	G.W.	H.F.	H.T.
2,343,117	Wingfoot Corp.: Vincent	Heat sealing of rubber hydrochloride plies	—	—	X
2,354,714	Budd Wheel Comp.: Strickland	Method of apparatus for heating thermoplastics	—	X	—
2,354,989	Fusco	Device for heat-sealing plastics such as Pliofilm or Cellophane	—	—	X
2,364,870	Western Lithograph Comp.: Otto	Method of producing laminated plastic articles	—	—	X
2,367,725	Udylite Corp.: Lindh and Phillips	Method for joining thermoplastic materials	X	—	—
2,370,624	R.C.A.: Gillespie	Electrical heating method	—	X	—
2,372,406	Miles Labor. Inc.: Treneer	Package and method of making same	—	—	X
2,372,737	Udylite Corp.: Phillips	Torch for welding thermoplastic material	X	—	—
2,376,253	Doughboy Mach. Inc.: Humphrey	Sealing machine	—	—	X
2,376,360	Nat. Urn Bag Comp.: Irmscher	Device for heat sealing package seam joint	—	—	X

U.S.P. No. 2,354,714 is identical with Br. P. No. 565,592.

Canadian Patents.

No.	Inventor	Subject-matter	G.W.	H.F.	H.T.
422,945	Wingfoot Corp.: Vincent	Film heat sealing method	—	—	X
422,947	Wingfoot Corp.: Carney	Lap joint in heat sealable plastic	—	—	X

Canadian P. No. 422,945 is identical with U.S.P. No. 2,343,117.

Swiss Patents.

No.	Inventor	Subject matter	G.W.	H.F.	H.T.
161,620	?	Method and apparatus for the welding of thermoplastic sheets	—	—	X
82,887	Jarrard, Moritz and Zade	Welding of thermoplastics (similar to Br.P. 555,054)	—	X	—

Australian Patent.

No.	Inventor	Subject matter	G W.	H.F.	H.T.
118,453	Arc Mfg. Co.: Jarrard, Moritz, Zade	Improvements in or relating to the electric heating and working of thermoplastic or thermosetting materials (same as Br.P. 555,054)	—	X	—

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Electro-plated Plastics

By E. E. HALLS

IN recent years, there has been much attention and a fair amount of publicity given to the subject of the metal finishing of plastic materials, and of articles fabricated from them by machine and moulding methods. Progress has been particularly evident in America, from which source samples have been demonstrated which, plated many years ago, still exhibit coatings that are tenaciously adherent. These were apparently finished without using the graphite process of providing the primary conducting layer. The modern processes of the Metaplast Corporation of New York avoid this pretreatment, and they appear to be the basis of the major commercial practice in America to-day. In view of this, a study of the Metaplast patents and of recent technical publications is of interest, and this is presented below. However, before attempting this, it is not only apt but also advisable to prelude the subject with a few " pros and cons " of the position.

Undoubtedly, electro-plated plastics serve a number of useful fields, and in some of these plastics alone could not satisfy the requirements, and other raw materials cannot easily fulfil the need. Plated plastics provide a neat, decorative appearance and enable a raw material that is one of the lightest available to be used. Thus, the commoner plastics have a specific gravity of 1.0 to 1.3, as against about 1.8 for the magnesium alloys and 2.7 for the aluminium series of light alloys. Electro-plating need not significantly add to this weight, so that the product would be about two-thirds of the density of magnesium alloys, and from one-third to one-half of that of the aluminium alloys. However, they are generally more likely to compete with steel and brass, of which they are approximately one-eighth of the density. Moreover, articles that are required to be plated in bulk can generally be made more conveniently than they can from metal.

For such items as jewellery, trinkets, ornaments and dress fittings (buttons, buckles and the like), there is indisputably a field for electro-plate finishes on plastics. Good wearing properties and good, permanent adhesion are the requirements, in addition to artistic appearance. Furnishings and fitments for automobiles fall in the same category, but in this field resistance to weathering must be added to the essential criteria.

Advantages and Disadvantages

In the electrical field, screening for audio frequencies, and for high and ultra-high frequences, is only one obvious requirement. Plastics are rapidly supplementing and replacing ceramics in many applications. To record a real encroachment upon this field it must be possible to metallize local areas for providing electrical contact, for screening or for soldering. Ceramics, of course, can be treated by a silvering process which involves high temperature firing to achieve this end quite satisfactorily. For the plastics there is need for an alternative process and electro-plating is one means of achieving this end.

It is considered that inexpensive plastic sheet material will find a good field to explore in packaging, and metal plating of such sheet material can make it impervious to moisture. This suggests a simple way to devise tropical or moisture-proof packings for many classes of goods.

The foregoing are a few points on the credit side.

However, the proposition is by no means one-sided. Plastics are primarily expensive, even on a weight-for-weight process. Hence, they can only be justified when greater ease of fabrication dictates their choice, or when their own

properties render them the obvious selection. Again, electro-plating is not easy; first, because films have to be rendered conducting; secondly, because plating initially must be slow on account of the very thin conducting layers applied; and, thirdly, because many of them may tend to be absorptive and all chemicals used in each stage of the process must be washed free before the subsequent stage, and before the plated articles can be passed to service. Otherwise, many premature failures and much disappointment are inevitable. Further, there are other means of metallizing, and these should not be overlooked, and one or other of them should certainly be adopted if apt to the specific problem.

These points on the debit side are stressed because any tendency to develop a "plated plastic complex" must be avoided. While appreciating that plated plastics are established commercially, it must be understood that at present the processes involved entail new techniques, which must be acquired and developed gradually to perfection over a long period of time in relation to the numerous types of plastic composition concerned, and the variety of configurations of components that are likely to come into the picture. In the ultimate, it will no doubt prove that the operations concerned are no more intricate than those associated with the electro-plating of zinc alloys and of aluminium alloys, in which problems arose that, after many years of work, became fully solved in a commercial manner, although even to-day a number of platers are not too sound in their techniques. The same position arose with the magnesium alloys, the commercial plating of which still remains to be solved. Commercial advancement will only be achieved by making a start, and this is satisfactory if it is on a sound basis, with full cognizance of the pitfalls so that they can satisfactorily be safeguarded.

In these senses, the Metaplast processes can be welcomed; they are designed to meet the peculiar conditions arising with the plastic materials, and from evidence available seem to fulfil all the requirements satisfactorily, and still leave some latitude in the processing operations. In the "Iron Age," February 1, 1945, Stanley H. Brams contributed an article on "Plated Plastics," which gives general information upon the fields served and the properties of the product. A summary of this with illustrations and tabulated data is given in the following.

Brams claims two advantages for plated plastics, a proportion of the physical attri-

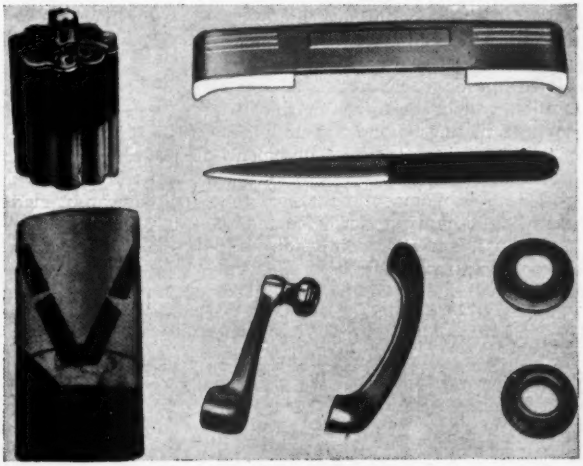

Fig. 1.—Examples of electro-plated objects of phenolic and cellulose plastics. E.g., the base and cap of the cigarette box are plated with copper and then with gold.

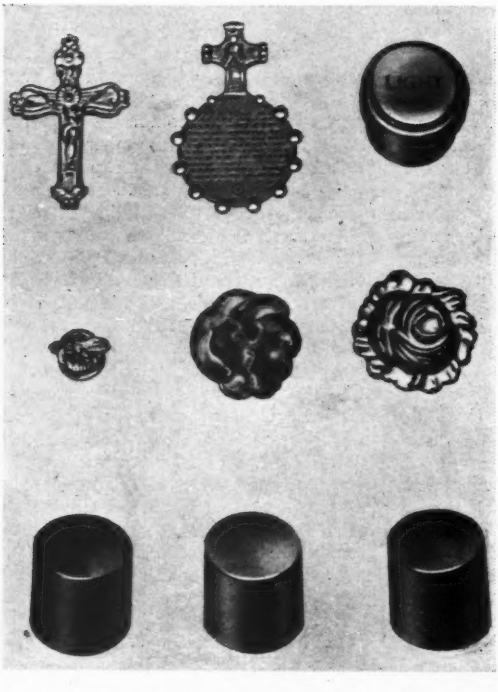

Fig. 2.—Cellulose acetate and methacrylate mouldings. Some are flash silver and gold plated. Platings of oxidized silver, etc., are also employed.

butes of the metal combined with the light weight of plastics, and, in the decorative sense, a combination of the brilliant colour of plastics with the gleam of metal. As established applications, he mentions plated plastic buttons on retail sale, plated plastic caps in use on perfume bottles, and lead platings as shields and copper platings for conductivity on plastic for aircraft radio equipment, in which lightness is a first essential. For post-war development, Brams foresees extension to hardware for home and automobile use, and for electrical appliances. The plating of a plastic base followed by cutting a helix to give the effect of a closely spaced wound coil is one proposition being examined. The possibility of using plated plastics for the interior hardware fittings of motorcars is also being given serious attention.

Fig. 1 shows a variety of electro-plated plastic commodities, which use copper, copper/nickel, copper/gold, and copper/nickel/chromium platings on phenolic resin plastic, bakelized wood and nitrocellulose plastic.

Fig. 2 shows a range of articles including cellulose acetate and methyl methacrylate plastics; flash silver and gold platings, copper/nickel/chromium, copper/flash gold, oxidized silver and copper are the platings represented.

Brams stresses the cost factors, and candidly states that cost is a stumbling-block to the replacement of common metals by plastics except where merit by virtue of properties justifies the replacement. He predicts that this may prove fatal to the exploitation of plated plastics for automobile hardware, because in this industry costs have to be figured to a fraction of a penny. On the contrary, in luxury and decorative applications, weight saving may increase appeal and overbalance the cost aspect. But he agrees that applications exist where plated plastics justify themselves, and in which they can be made to justify themselves.

Brams instances a specific investigation which is of special interest. This concerns aluminium castings, which, coming from the mould in a rough condition, require machining before electro-plating. An investigation was undertaken to determine the feasibility of coating the metal casting with plastic by simple means to a thickness of 0.010 in. or thereabouts, and then electro-plating the plastic. Undoubtedly this would require a study of very specific

Fig. 3.—Irregularly shaped articles are loaded into mesh baskets for plating. The baskets are suspended from an eccentric actuated by a slow-speed motor.

nature and, although there are undoubtedly instances in which a dual plastic/metal coating may be advantageous or necessary (in fact, there are many instances existing), it is not too obvious that the example indicated would fall in this category. A case that may be worth exploring concerns a non-metallic base, namely, the electrical screening of glass radio valves. Here, at present, a common practice is to apply a plastic coating first, usually through the medium of a special nitrocellulose-base lacquer or synthetic resin solution, which serves as the base of a sprayed metal coating. By electro-plating, a smoother finish could be obtained, a thinner coating applied, a wider choice of metal for the coating would be possible, and perhaps the serious corrosion troubles encountered in abnormal tropical conditions mitigated.

A particularly commendable feature that Brams brings out is "design for plating." Any plastic can be plated, but to date the thermosetting types are preferred. This is on account of their greater stability. Reflex portions, such as grooves, do not plate well, the normal throwing-power difficulties arising. The plating in the groove will be cloudy in comparison with the rest of the deposit. Again, if plating to appreciable thickness, fine detail may be masked or lost.

Five methods are generally employed for rendering the base material conductive and one of the oldest is silvering. This is part of the basis of the Metaplast patents. These have been licensed to the Monroe Auto Equipment Co., of Michigan, for exclusive exploitation in the automobile field and for any other spheres that it chooses to develop. The

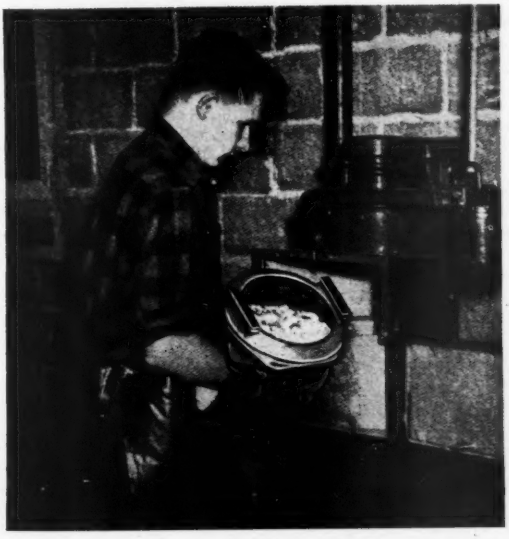

Fig. 4.—After plating and buffing, etc., small objects are lacquered in this centrifuge. The solid metal basket, which contains the lacquer, lowers in the machine column to accommodate the wire basket, containing the pieces. After immersion in the lacquer, the pieces are spun and freed of excess.

Monroe Co. operates a small plant aggressively and contemplates expanding as soon as conditions permit.

The Metaplast process stipulates a preparatory treatment in tin chloride and hydrochloric acid, followed by silvering, and this furnishes the adhesion; electroplating in the orthodox manner can then proceed. Figs. 3 and 4 are particularly interesting in demonstrating the normal electro-plating shop character of the job. Fig. 3 shows the wire mesh baskets into which irregular-shaped articles can be loaded for plating. The baskets are suspended in the solution from an eccentric which is actuated by a slow-speed motor. The gentle motion imparted promotes evenness of plating and prevents formation of pockets. Fig. 4 shows the centrifugal lacquering of small plated articles. The lacquer is contained in a solid basket, into which the wire-mesh container of small articles is immersed. The lacquered container is then lowered, and the basket of parts is whizzed to remove excess lacquer and to dry off.

The Monroe Co. have plated all the common metals on to plastics, namely, tin, silver, gold, nickel, cadmium, zinc, copper and chromium, and they can readily do rhodium, lead and palladium, if required. Cadmium, chromium and zinc are the most widely used. Gold is the only metal that utilizes a special electrolyte, and this is for economic reasons; the solution used is patented. Regarding the plastic base, they find that certain plastics respond more readily than others. Lucite (methyl methacrylate), Bakelite (phenol formaldehyde types), Plaskon (urea formaldehyde), and the butyrates are found to be especially good. The furfural types are satisfactory, but the vinyl group does not behave too well.

The Monroe technicians favour a minimum thickness of electroplate coating of 0.0003 in. if buffing or burnishing is to be attempted. The maximum thickness is only limited by such factors as cost, weight and obliteration of detail in the surface of the article and, in consequence, for general purposes, provided that the minimum thickness is employed, the closer the plater works to this minimum the better.

Polishing is done by buffing or, if the nature of the work permits, by tumbling with steel shot in barrel machines. Here again, the parallel exists with ordinary electroplating practice.

Apart from establishing the practical technique and market for electroplated plastics, the Monroe Co. has determined the physical characteristics of the coatings with respect to tensile strength, impact strength, corrosion propensities and water absorption of the finished product. Some of their results are reported below.

Tensile strength was examined on rectangular strips having a duplex plating consisting of 0.0025 in. of copper as undercoat and 0.0005 in. of cadmium as top coat. Results for plated and unplated specimens are given in Table 1 and graphically in Fig. 5. The 50 per cent. improvement by virtue of the plating on two of the phenol formaldehyde specimens and about 30 per cent. for urea formaldehyde and polystyrene, should be noted.

Table 1.—Comparison between Plated and Non-plated Plastics.

Specimen	Tensile strength, lb. per sq. in.	
	Plated	Unplated
Phenol formaldehyde	8,550	8,075
Phenol formaldehyde	9,350	6,300
Urea formaldehyde	10,450	8,050
Polystyrene	4,225	3,038
Methyl methacrylate	11,575	10,700
Cellulose acetate	4,825	4,213
Phenol formaldehyde	8,450	5,675

Findings are averages of two specimens.
Plating: Copper, 0.0025 in., cadmium, 0.0005 in.

Under corrosion tests, the plated coating merely corrodes away as in erosion. There is no corrosion of the underlying plastic. The coating is somewhat akin in this respect to anodic or electropositive coatings on metals, e.g. zinc on steel. It is distinctly different from electronegative platings on metals, e.g. nickel/chromium on steel, in which the steel rusts and pushes off the coating which protects only

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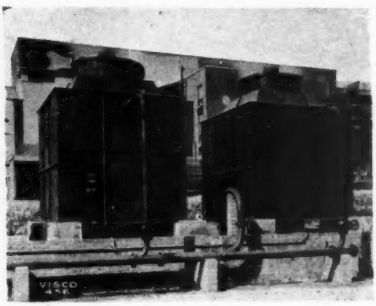

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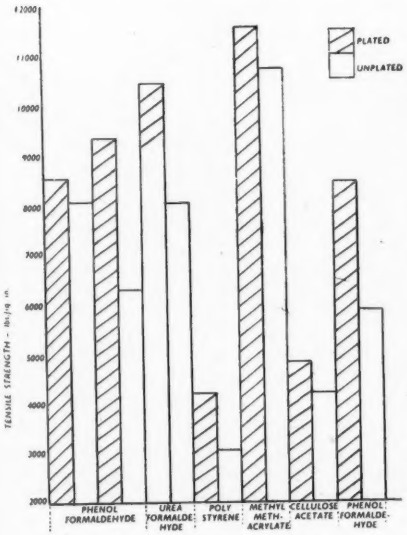

Fig. 5.—Tensile strengths of plated plastics.

by virtue of being an envelope. Therefore, adhesion is not lost and the life of the coating is that of the particular thickness present under the degree of corrosiveness obtaining.

Resistance to moisture, oils and solvents is an attribute of plated plastics. This is seen from Monroe's figures. In one case, cellulose acetate sheet absorbed 2.6 per cent. by weight upon immersion for 24 hours, but the same material electroplated gave a value, under the same conditions, of nil. The same trend is shown for various plastics in Table 2 and graphically in Fig. 6, the plating being the same copper/cadmium combination as employed for the tensile tests.

Improved impact strength is also a virtue imparted by electroplating. The values given in Table 3 and Fig. 7 show up to 50 per cent. improvement in this property, out of all proportion to the weight added by the thickness of coating.

This information enlarging on the Metaplast type of platings, renders a more detailed study of their patents of interest.

Walker (Bernard F.), Assignor to The Metaplast Corporation of New York, holds two patents appertaining to the metal coating of plastic bodies, namely, U.S. patent Nos. 2,303,871 (1942) and 2,214,646 (1940). The early one of these covers a process for the treatment of the surface of the plastic material so that an adherent metallized layer may be applied to it. The intention is that this layer may form the base for subsequent electroplating, or in certain instances, it may be polished or otherwise treated to provide the finished surface. Covering a wide range of plastic base materials, it relates to the metallizing of hard rubber, phenol condensation products, urea resins, synthetic resins, cellulosic plastic materials or materials coated therewith.

The patent states that it has been found that these plastic materials, particularly those having a hard surface, must be pretreated so as to reduce the surface to a form adapted to receive the metallized coating. The pretreatment produces a physical and chemical change in the surface which is such that causes the metallized coating to adhere satisfactorily, although the change induced is not visually apparent. Walker attributes the result to a depolymerization of the portion of the surface so treated. For example, the material may first be depolished and cleaned. It is then treated with the depolymerization substance for a suitable length of time to bring about the degree of surface reduction that is required. The depolymerizing substance is then

Table 2.—Water Absorption of Plated Plastics.

Specimens	Water Absorption in 24 Hr. Percentage of Weight	
	Plated	Unplated
Phenol formaldehyde	0.095	0.460
Phenol formaldehyde	0.070	0.380
Urea formaldehyde	0.060	0.450
Polystyrene	0.020	0.060
Methyl methacrylate	0.010	0.240
Cellulose acetate	0.070	2.150
Phenol formaldehyde	0.120	0.620

Findings are averages of two specimens.
Plating: Copper-cadmium, as in Table 1.

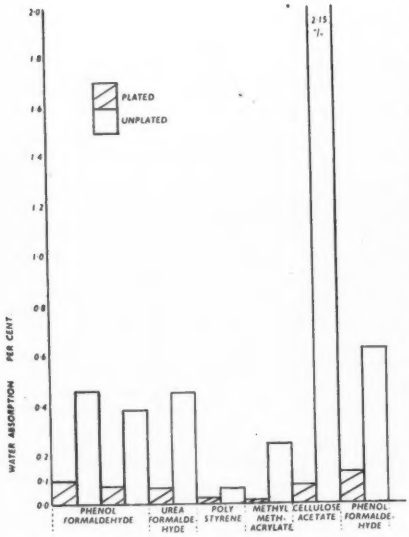

Fig. 6.—Water absorption of plated plastics.

removed, the material surface is washed, and a suitable silver solution is applied in order to deposit silver on the surface as a metallized coating. This coating is sufficiently adherent to be polished and used as such, or it may form the vehicle for subsequent electroplating.

One method of carrying out the process given in the patent is as follows. Material such as phenol condensation product or other synthetic resin is first depolished. This may be done by chemical means by using a reagent which has the properties

Table 3.—Impact Strength of Plated Plastics.

Specimens	Notched Izod Value Ft.-Lb.	
	Plated	Unplated
Phenol formaldehyde	0.430	0.335
Phenol formaldehyde	0.430	0.320
Urea formaldehyde	0.350	0.295
Polystyrene	0.365	0.240
Methyl methacrylate	0.365	0.355
Cellulose acetate	2.705	2.290
Phenol formaldehyde	0.480	0.330

Findings are average of two specimens.
Plating: Copper-cadmium, as in Table 1.

of depolishing the surface, or by mechanical methods such as sand blasting. The second step is to clean the material free from all foreign agents by means of a suitable solvent such as petrol. The third stage is immersion in a solution of stannous chloride. This reverses the polymerization or other action to which the material had been subjected and which rendered the surface immune to the action of most chemicals and solvents, and it depolymerizes or otherwise alters the condition of the surface so that a definite affinity is produced for the metal that is to be deposited. The stannous chloride solution used is preferably of a concentration such that a milk-like consistency is obtained, and it must be kept constantly agitated during use in order to keep the stannous chloride in solution. The time required is dependent upon the hardness of the surface being treated. Some materials, such as phenol condensation products, require an hour for depolymerization, whereas others, such as hard rubber, may require 30 minutes. The fourth stage is the removal of the stannous chloride solution from the surface of the material, and thorough washing of the latter in order to remove the reagent as completely as possible. The fifth stage is treatment in a silver bath to precipitate silver on the material. The silver bath may comprise a solution of

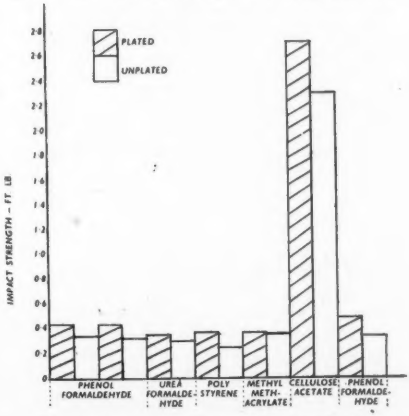

Fig. 7.—Impact strength of plated plastics.

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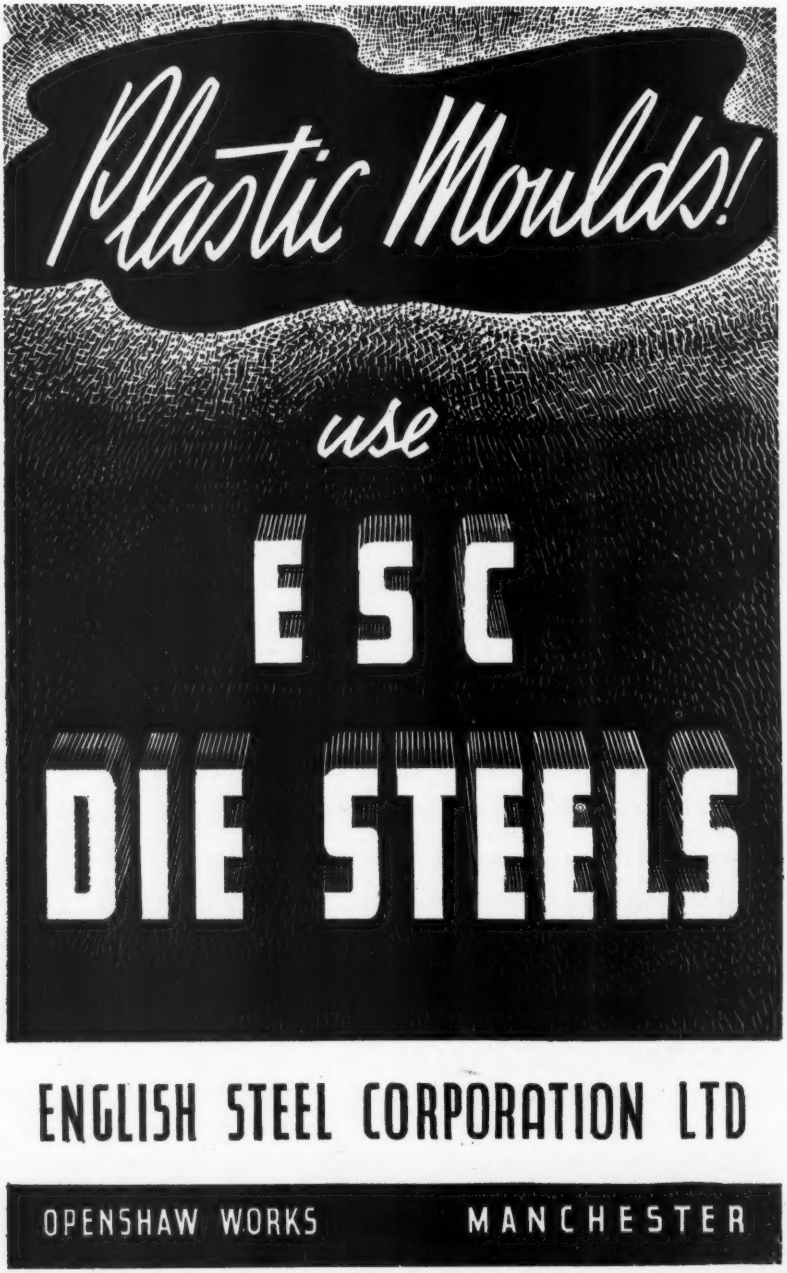
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sodium potassium tartrate and silver nitrate which is mixed with a solution of silver nitrate and ammonia, this being applied to the surface under such conditions that the sodium potassium tartrate precipitates silver from the silver nitrate on to the surface of the material. The thickness of the silver layout will in general be dependent upon the time of contact between the solution and the material. For preference, the solution should be agitated or maintained in constant flow over the surface so that a fresh part of the solution is always in contact.

The surface is then ready for polishing or to serve as the conducting medium for electrodeposition. For the latter purpose, normal practice follows with respect to suspending the object as cathode in the appropriate electrolyte or orthodox composition, and plating till the desired thickness is built up.

It is pointed out that in certain instances the initial depolishing may be omitted. This may be when the metallized coating is required as the final finish, especially on cast resin and thermoplastic materials. It can be omitted when electroplating is the ultimate objective only if the plating is to be so thin that it will not possess sufficient tensile strength to be peeled off, or if it is so thick that in itself it is strong enough to resist peeling.

The patent points out that the process is particularly adapted to the treatment of part-surfaces, as by stencilling, to obtain electroplated designs, for novelties, jewellery, ornaments and the like.

The second patent is a continuation of the same subject. In this, information is added on the depolishing treatment in so far as it is stated that a solution of sodium hydroxide, preferably a normal solution, can be used for cellulose acetate products. Walker calls it a priming solution, which has the property of cleaning or of conditioning the surface.

With respect to the stannous chloride solution, he adds that the addition of hydrochloric acid is beneficial because it decreases the time period for this treatment. Sufficient hydrochloric acid to render the stannous chloride solution clear, and maintain it clear in use, is recommended. An example is:—

Stannous chloride, 360 gms.
Hydrochloric acid, 216 c.c.
Water, 4,000 c.c.

This solution is said to remain perfectly clear and to complete the treatment in a very short time. The work may be dipped in the solution, or the solution applied to the surface, and the time required is 45 secs. to 1 min., but much flexibility can be had by balancing concentration and treatment time.

For the silvering solution, formaldehyde is mentioned as one ingredient that can be used instead of the tartrate solution, e.g. 22 c.c. of 40 per cent. formaldehyde in 16,000 c.c. of water, with or without the inclusion of a small amount of silver nitrate. For the silver solution itself, the following is cited:—

Silver nitrate, 33.3 gms.
Ammonia (28 per cent.), about 28 c.c. to clear the solution.
Water, 16,000 c.c.

The solutions are prepared separately and only mixed together when required for the actual metallizing.

It will be seen that the commercial plating of plastics involves the following operations:—

(a) Roughening or depolishing.
(b) A tin chloride immersion treatment for giving the correct bonding surface.
(c) A silver immersion process for providing a conducting layer.
(d) Orthodox electroplating.

Water washes are required after each chemical process. The methods employed are not foreign to normal electroplating shops, although the plastic raw material is new to them, and the techniques in themselves require more than usual care and control. Whether electroplating is adopted for novelty and decorative purposes, or for utilitarian ends, firstly it should only be decided upon if it is apt to the design and application, and, secondly, every effort should be made from the outset to establish and maintain a sound sequence of processes.

Testing Laminate Adhesion

After W. Weigel, "Kunststoffe," 1944/34/76. A method is described whereby all the component sheets in the laminate are tested in such a way as to give rapid results, particularly under production conditions where a great number of specimens must be examined in a short time

THE mechanical properties of laminated plastics show great variations according to the direction in which stress is applied. Whereas a load parallel to the direction of laminations is mainly supported by the fillers, i.e., paper or fabric, a load perpendicular to the direction of laminations is carried only by the binder between the laminations, i.e., by their adhesion. Even if, in the majority of applications, the first kind of leading is preponderant, the adhesion of the laminations is also of importance. It is, for instance, essential in all bending stresses, as the shear forces tend to displace the single laminations. Further, the machining of plates, in particular of thick plates, is only possible when the laminations adhere well, otherwise "breaking out" will occur.

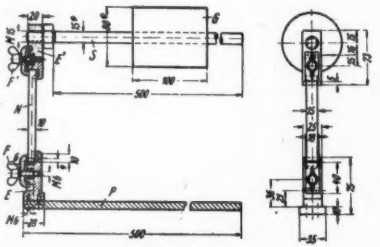


Fig. 1.—Plan and elevation of testing apparatus according to Weigel. It is stressed that with this equipment adhesion of the laminates is not assessed on the results of a single pair of sheets selected at random. For key to diagram see text.

This property has usually been tested by determining resistance to splitting. A standardized wedge is placed on the sample parallel to the direction of laminations and loaded by a weight. The splitting resistance is that load in kg. which splits the sample. This test has a number of disadvantages. It does not test all laminations, but leaves it to chance whether the only unreliable lamination is that one selected for test. Great care is necessary, too, as the wedge has to be placed very accurately into the direction of laminations; even small deviations can cause considerable errors.

It was considered necessary to develop an improved testing method, which had to fulfil two main requirements; it has to test all laminations of the sample, and should be quick and simple in operation in order to test a large number of plates in a short time.

The new method uses a standard sample (with the long axis perpendicular to the laminations) which is subjected to a bending test. This sample can be easily cut out from a plate. The test is carried out by the simple instrument shown in Fig. 1. It consists of a base (P) to which a clamp (E) with wingnut (F) is attached. The sample (N) is fixed in the clamp (E) and to its free end another clamp (E), operated by wingnut (F), is applied. The upper clamp carries a bar (S) on which weight (G) can slide. The bending stress of the sample is constant throughout its length and can be adjusted by varying the position of the weight. Clamping and adjustment of the sample (N) is very easy; the clamping jaws are between $\frac{1}{16}$ to $\frac{3}{8}$ in. in size in order to ensure a safe hold of the sample. These

portions of the sample are not stressed to the full stress, therefore only plates of a thickness exceeding $\frac{3}{4}$ in. can be examined (the illustration shows, however, a plate of about $\frac{5}{8}$ in. thickness). When carrying out the test, the weight should be supported at first by the hand, and then slowly released. Such a cautious increase of the load is to be recommended.

The instrument is useful as a rapid testing method in production. A scale provided on bar (S) can be used for reading directly the bending stress. The weight (G) has to be shifted slowly along the bar. For controlling production, it is only necessary to find out whether a prescribed minimum value is maintained; therefore the weight is brought in such a position as to correspond to this minimum stress. Frequently the testing of a single sample is all that is necessary, as experience has shown that bad adhesion of a single layer can be caused by one bad paper or fabric layer which runs through the whole plate.

THE ABRASAW

(Continued from page 484)

iron tables, one of which is recessed to accommodate the abrasive wheel and is hinged to provide access to the wheel and flanges. The other table is mounted on hardened steel balls running in steel vee ways. These ways are ground and are automatically wiped free of dust by the movement of the table, thus preventing clogging. Ample support is assured throughout the 48-in. travel of the table, which is fitted with brackets to carry clamps and measuring devices.

The wheel guard, in addition to protecting the operator, carries adjustable rollers which hold down the material at the cutting point, eliminating vibration of the material and thus ensuring a smooth finish.

The lower part of the abrasive wheel is accommodated in an exhaust duct connected by a pipe to the exhaust unit, which will deal efficiently with the very fine dust produced by cutting with an abrasive wheel.

Some of the dust is inflammable, abrasive and often gives off obnoxious fumes, conditions which cannot be dealt with satisfactorily by a conventional exhaust system.

The dust and fumes are drawn away from the duct in the machine by a fan driven by an enclosed motor in the exhaust unit. Here the dust impinges on a chute comprising a series of weirs over which water, circulated by a motor-driven pump, cascades; the dust is, therefore, submerged and carried to a sump where it collects as sludge. A wheeled tank is supplied for the removal of the waste.

A connection is provided on the top of the exhaust unit so that an outlet pipe may be taken to the atmosphere to disperse any fumes.

The rate of cutting on the machine depends on the thickness of material. The hand feed of the table is extremely sensitive, feeds from 1 in. to 4 ins. per second being quite usual.

Although the capacity of the machine is 1-in. thickness of material by 48-in. length of cut at one setting, on certain classes of work a 16-in. wheel may be used to cut up to $1\frac{1}{2}$ ins. thick.

All electrical equipment supplied is for 400-440 volts, three-phase, 50 cycles.

The manufacturers are Small Electric Motors, Ltd., Beckenham, Kent, while the sole selling agents are Alfred Herbert, Ltd., Coventry.

The Gauge and Tool Makers' Association

The Association is arranging an exhibition of its member-firms' products which will be held in the New Hall, Vincent Square, London, S.W.1, during the fortnight, Monday, January 7, 1946, to Saturday, January 19, 1946, inclusive.

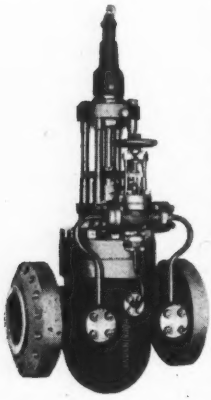
The area of the New Hall is approximately 20,000 sq. ft., and nearly 100 member firms have reserved stands, which will all be erected to a uniform design. The products to be shown will be, broadly, gauges and measuring equipment, jigs, fixtures and special tools, press tools, moulds and dies, and diamond tools and gauges.

Invitations to attend the Exhibition are to be issued on the widest possible scale to officials in all Government and Service Departments, trade delegations, and a very large number of overseas buyers and prominent industrialists abroad, etc.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

THE PARALLEL SLIDE VALVE.—One of the outstanding inventions of steam practice is the parallel slide valve, the use of which has been standardized throughout the world for half a century past, introduced by Hopkinsons, Ltd., of Huddersfield, who incidentally, during the past year or so, celebrated their centenary, having started in business in 1843, constructing high grade steam engine and boiler fittings and accessories.



The parallel slide principle for stop valves—that is, with a pair of discs sliding over parallel faces, giving a fluid-tight joint without any wedging action or other mechanical stress — was invented by the firm in 1881, the original design having a cast-iron body and gunmetal working parts. During the following year the principle was also applied to blow-off valves. In 1904 appeared another famous application of the parallel slide valve, the "Hopkinson-Ferranti," designed in collaboration with the late Dr. S. Z. de Ferranti, the general features being similar to the parallel slide valve, but with the bore in the form of a converging-diverging nozzle. To-day this valve is being used for the highest pressure up to 2,000 lb. per sq. in. Typical of the firm's latest practice is a valve of this type fitted with a by-pass and equalizing valve operating at 1,600 lb. per sq. in. steam pressure and 965 degrees F. superheat, and arranged for operation by remote electrical control. Special alloy steels are, of course, used in this connection, depending upon the pressure and temperature, along with "Platnam" hard and resistant alloy for the valves and seatings.

The firm during the past few years have also systematically developed the use of the slide valve principle as standard practice for other productions because of its efficient, durable and trouble-free operation. In this connection other of the main advantages are a full uninterrupted passage through the valve, the discs are free to rotate on their own axes so as to give uniform wear, with the faces maintained in perfect condition, and all parts are easily accessible and interchangeable. Thus in 1930 the principle was adopted for drain valves down to sizes as small as ¼-in. bore, and in 1932 became standardized for the firm's "Nolos" steam trap. Following this, parallel slide action was adopted in 1933, for condensate return-traps, and in 1934 to an external type high and low water alarm. The most recent example is the use for the gauge arms of steel water gauges.

RADIELECTRIC PRE-HEATING.—An excellent little booklet under the title of "A Year's Experience of Radielectric Pre-Heating" (the name has been selected as being preferable to "Heatronic Moulding") has been published by British Industrial Plastics, Ltd.

The notes have been compiled by Mr. J. E. Beard, of Streetly Manufacturing Co., Ltd., and are a praiseworthy attempt to estimate the running costs of radio-frequency pre-heating when used on a production scale.

The importance of the process to the economy of the moulding industry is such that the findings of the author are of the highest value. They are based on a year's experimental work followed by six months' practical application in a British moulding factory.

British Industrial Plastics, Ltd., is making the booklet available to all moulders.

SOCIETY OF BRITISH PAINT MANUFACTURERS, LTD., has been formed by a body of small, large and medium manufacturers representing an important section of the paint industry.

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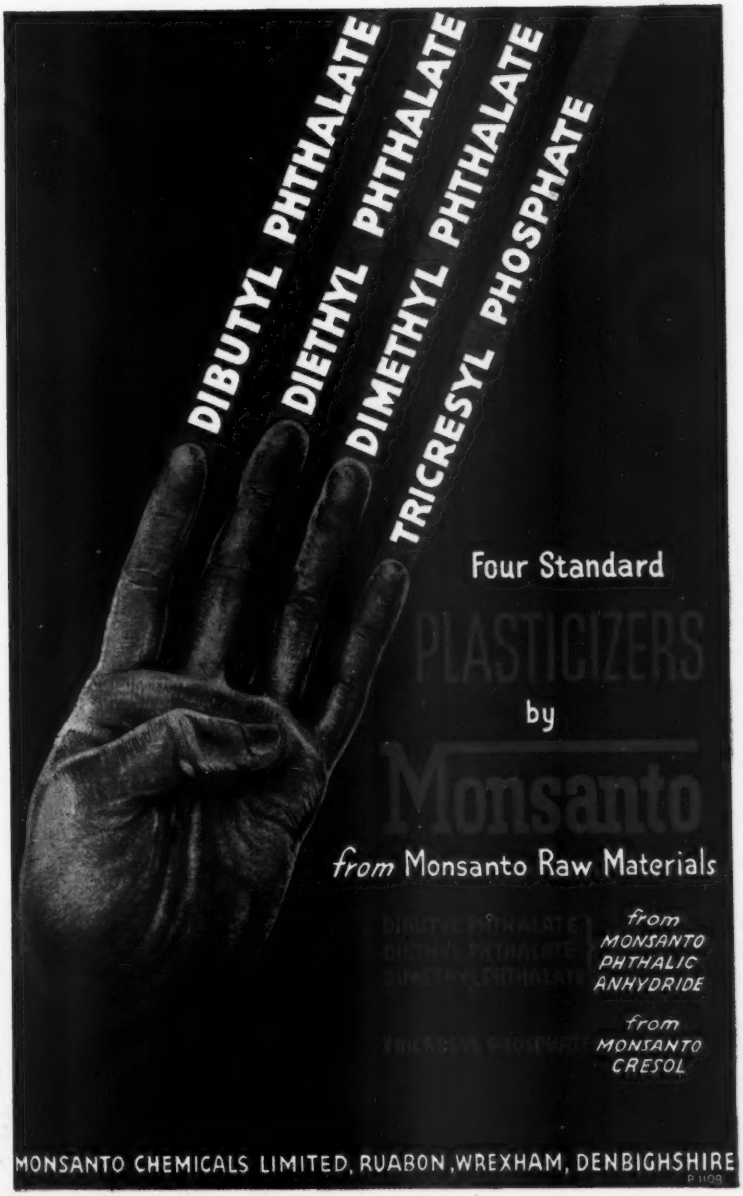
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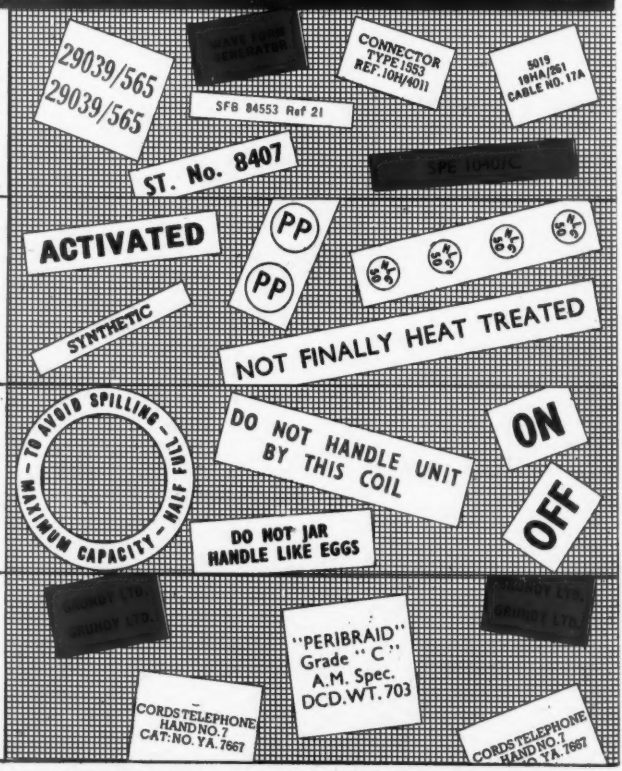

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the interest of the consumers of its products, so that a complete liaison will exist. The Society hopes to form a strong policy for the development of home and export trade and for conserving the industry's capital structure.

The Society aims to resist monopolistic tendencies of restraint on material, to resist at all times interference with free enterprise, and to serve the National interest by co-operation with all Government departments, and with other organizations within the industry, recognizing the specialist interests that exist and justify such organizations.

The offices of the Society are at Amberley House, Norfolk Street, Strand, London, W.C.2.

I.C.I., LTD.—Mr. F. E. Smith and Mr. J. L. S. Steel have been appointed by the board of I.C.I. to be additional directors. Mr. F. E. Smith was chief engineer and a member of the board of the Billingham Division of I.C.I., and for a large part of the war has been acting as Chief Engineer and Superintendent, Armaments Design, at the Ministry of Supply. Mr. J. L. S. Steel has, since 1943, been chairman of the Alkali Division of I.C.I.

Other appointments announced are that Mr. W. M. Inman, formerly sales controller of I.C.I., has been appointed chairman of the Alkali Division in place of Mr. J. L. S. Steel. Mr. E. M. Fraser, lately Director-General of Aircraft Production, has returned to I.C.I. as sales controller in place of Mr. W. M. Inman. Mr. A. T. S. Zealley has been appointed chairman of the Billingham Division and Mr. V. St. J. Killery, from Billingham, to be chairman of the General Chemicals Division. Mr. S. A. H. Whetmore has been appointed managing director to the Billingham Division jointly with Mr. K. Gordon.

MR. L. P. B. MERRIAM, M.C., is being released from his appointment as Controller of Plastics. Correspondence should, in future, be addressed to the Ministry of Supply, Raw Materials Department, Plastics Materials Section, Terminal House, 52, Grosvenor Gardens, London, S.W.1. Telephone No. Sloane 2271.

UNITED STEEL NEWS.—Dr. J. H. Chesters, of the Central Research Department of the United Steel Companies, Ltd., has just been awarded the degree of Doctor of Technical Science by the University of Sheffield, for his outstanding researches on refractories.

Dr. Chesters is now engaged on work in the field of open-hearth furnace design. The research is of such a nature as to constitute a new approach to the problem of finding suitable refractories to meet the fast working conditions of the furnace of the future.

BIRKBYS, LTD., Liversedge, Yorks, Manufacturers of " Elo " Plastic Products, have appointed Mr. D. W. Fletcher as Midlands Manager. His address is 837, Shirley Road, Hall Green, Birmingham, 28, and telephone number Birmingham (Shirley Green) Shi 1797. Mr. Fletcher took up his duties at the end of September.

BX PLASTICS, LTD.—Mr. J. E. Lonsdale, B.Sc., until recently employed with the Advisory Service on Plastics and Rubber, is now in the Technical Servicing Department of BX Plastics, Ltd.

SCOTTISH PLASTICS. — Mr. Brian Buchel has been appointed sales manager to Scottish Plastics, Ltd., and will shortly take up his new appointment in Glasgow. The company has a complete showroom and advisory service operating in the city, and has been responsible for considerable development in industrial and commercial uses of plastics in Scotland.

MR. NORBERT QUINN, with some 16 years of practical experience in the application of synthetic materials to the paint, rubber, aircraft, textile, shoe and leather industries, is now practising as a consultant with offices at 70, Victoria Street, London, S.W.1. Telephone: Victoria 2958.

DE LA RUE INSULATION, LTD., announce that by arrangement with the Metropolitan Vickers Co., Ltd., Trafford Park, Manchester, they will take over the section of the latter company's business manufacturing laminated plastics.

I.P.I. (SOUTHERN SECTION).—Following the annual general meeting of the Southern Section of the I.P.I., the new committee elected for the 1945-6 Session is as follows:—Dr. Harry Barron (Chairman), Messrs. L. E. Hoare (Vice-Chairman), G. L. Barron (Hon. Sec.), D. Bennett (Portsmouth), C. B. H. Clark, S. W. Darrington, T. Gilbertson, H. P. Grinyer, C. D. H. Hurdle, A. McAulay, R. Snoxell (Bournemouth), E. Spayne, H. G. Thew, C. Williams.

PATENT REVIEW

B.P. 570,326. Application date: 28.2.39. Accepted: 3.7.45.

Manufacture of New Interpolymerization Products. H. Gudgeon and R. Hill, Imperial Chemical Industries, Ltd.

By interpolymerization of monomeric esters of 1-carboxybutadiene-1:3 with monomers of acrylic acid, acrylonitrile, acrylic esters or substitutes thereof, new compounds are produced.

B.P. 570,329. Application date: 13.1.43. Accepted: 3.7.45.

Improvements in or relating to the Emulsion Polymerization and Copolymerization of Methyl Alpha-chloroacrylate. E. I. Du Pont de Nemours and Co.

Method of polymerizing methyl alpha-chloroacrylate in an aqueous medium containing salts of perdisulphuric acid and an acid-stable dispersing agent.

B.P. 570,330. Application date: 22.1.43. Convention date: U.S. 23.1.42. Accepted: 3.7.45.

Improvements in or relating to the Emulsion of Polymerization of Vinyl Halides. E. I. Du Pont de Nemours and Co.

Process for the manufacture of polymers of vinyl halides in an aqueous medium containing salts of perdisulphuric acid and an acid-stable dispersing agent.

B.P. 570,348. Application date, 20.10.43. Convention date: U.S. 21.10.42. Accepted: 3.7.45.

Improvements in or relating to the Production of Copolymers of Vinyl Chloride and Fumaric Esters. E. I. Du Pont de Nemours and Co.

Improved copolymers of vinyl chloride and fumaric esters are the subject of this invention, the improvements consisting in increased impact strength, ease of flow for moulding applications, increased flex resistance in coated fabrics, and prevention of discoloration by the action of heat or light.

B.P. 570,358. Application date: 28.2.39. Accepted: 4.7.45.

Manufacture of Polymerization Products. H. Gudgeon and R. Hill, Imperial Chemical Industries, Ltd.

Manufacture of polymerization products of monomeric esters of 1-carboxybutadiene-1:3 in aqueous emulsion or dispersion by heat or by means of catalysts.

B.P. 570,367. Application date: 15.3.43. Accepted: 4.7.45.

Improvements in or relating to the Manufacture of Resinous Compositions. Bakelite, Ltd.

Process for the preparation of oil-modified resinous compositions by reacting at temperatures between 115 degrees C. and 215 degrees C., a heat reactive phenol-aldehyde resin with fatty oils in the presence of an added acid catalyst.

B.P. 570,400. Application date: 14.5.43. Accepted: 5.7.45.

Improvements in or relating to the Polymerization of Organic Compounds. Imperial Chemical Industries, Ltd. Communicated by E. I. Du Pont de Nemours and Co.

Process for polymerizing halogen-free compounds containing a $CH_2 = C <$ group (other than acrylonitrile or homologues thereof) by activating such compounds prior to polymerization. Such activation is effected by washing the compound with an aqueous oxidizing solution. The subsequent polymerization can then be carried out by the usual methods.

B.P. 570,461. Application date: 17.9.43. Accepted: 9.7.45.

Improvements in or relating to the Adhesive Compositions comprising Polymerized Chloroprene and in or relating to Methods of Preparing such Composition. B.B. Chemical Co., Ltd.

B.P. 570,529. Application date: 27.9.43. Accepted: 11.7.45.

Improvements relating to Moulding Powders. E. Chippindale, Cotopa.

To overcome poor electrical properties of moulded articles due to fillers such as wood flour, etc., chopped-up or ground fibres of cellulose acetate are used as filler. This method is applicable to thermosetting and thermoplastic moulding powders.

B.P. 570,564. Application date: 15.12.41. Accepted: 12.7.45.

Improvements in or relating to the Manufacture of Polymerization Products from Polymerizable Organic Chlorine Compounds. H. P. Staudinger and H. M. Hutchinson. The Distillers Co., Ltd.

Process for the production of polymers, especially of vinyl chloride and vinylidene

chloride wherein this polymerization is carried out in the presence of hexamethylene-triperoxide-diamine in the liquid phase.

B.P. 570,588. Application date: 7.6.43. Accepted: 13.7.45.

Improvements in or relating to the Treatment of Yarns, Foils and Similar Materials Made of Organic Derivatives of Cellulose. F. B. Hill. British Celanese.

Stretching of yarn made from cellulose derivatives in a totally enclosed stretching chamber under pressure, the chamber being filled with an inert liquid, e.g., water. The chamber is subdivided into sections, one of which is filled with wet steam at a temperature of 130-140 degrees C.

B.P. 570,590. Application date: 24.6.43. Convention date: U.S. 30.10.42. Accepted: 13.7.45.

Improvements in or relating to the Manufacture of Vinyl Resin Filaments. American Viscose Corp.

Manufacture of artificial elastic filaments by extruding a solution of a vinyl resin and of an elasticizer in a volatile solvent through a spinerette into an evaporative atmosphere.

B.P. 570,596. Application date: 3.8.43. Convention date: U.S. 2.7.42. Accepted: 13.7.45.

Copolymers and Process of Producing them. J. C. Michalek. The Mathieson Alkali Works.

This invention describes the production of rubber-like materials by copolymerization of conjugated dienes and nuclear chlorinated styrene.

B.P. 570,618. Application date: 6.10.43. Accepted: 16.7.45.

Improvements in the Production of Artificial Threads by the Wet Spinning Process and in Apparatus therefor. R. S. Jones. Courtaulds, Ltd.

Method of suspending the inlet funnel of a centrifugal spinning box in such a way that the spinning thread guides the stem of the funnel in a reciprocating manner.

B.P. 570,620. Application date: 13.10.43. Accepted: 16.7.45.

Improvements in or relating to the Manufacture of Hollow Rubber Articles. C. A. Everitt and J. Heaton. T. B. André Rubber Co., Ltd.

Fabrication of bags, battery liners, etc., from natural rubber. Sheets of rubber are wrapped around a former and secured by means of clamps. The former is mounted on a trolley and moved into the curing chamber. Curing is then effected by means of steam. Special clamps for forming flanges are provided.

Chemical Research Laboratory

The Lord President of the Council has appointed Professor R. P. Linstead, M.A., D.Sc., F.R.S., to be Director of the Chemical Research Laboratory in the Department of Scientific and Industrial Research. Professor Linstead took up this appointment on October 1, 1945.

Professor Linstead was formerly Firth Professor of Chemistry in the University of Sheffield and in 1939 was elected to the Chair of Chemistry in Harvard University, U.S.A. During the war he returned to Great Britain and has rendered valuable service in relation to the application of science to war problems. In 1942 he became Deputy Director of Scientific Research in the Ministry of Supply. During the past year he was British Chairman of the Combined Intelligence Objectives Sub-Committee who were responsible for organizing the investigation of German military scientific developments.

Low Density Laminates

Contoured sections may now be moulded in one operation which produces a strong, and light-weight combination of materials. Curved moulds and sand-filled "Cellophane" bags readily form ribs to the desired shape. Plies of resin-impregnated canvas or paper are built around these tubes, in combination with various face plies. The moulds should also prevent lateral displacement of sand-filled tubes during moulding. The entire assembly is completed in a relatively short period of time, forming integral ribs. The methods have been applied to resin-heated crêpéd paper and low-pressure polyester resins. Many composite laminates were prepared with metal after first spraying a primer coat on metal surface. Laminated plastic ribs were formed integrally with these surfaces. —C. A. Scogland, "Plastics" U.S.A., July, 1945.

Planned Mould Maintenance Service Aids Economical Production

Section XVI

By W. M. HALLIDAY

In this section consideration will be given to still more interesting illustrated injection mould constructions incorporating rapid feeding or locating devices for pre-formed inserts.

Especial attention will be devoted to design, constructional and operating features of a number of simple pre-loading mechanisms capable of ready application and economical use in moulds where fully automatic magazine-type feeding plates are precluded.

Employment of such devices here described usually entails some complication in the mould design, and the consequent greater possibility of operating troubles such as wear, distortion, misalignment and so on. Moulds of this type generally demand closer maintenance oversight and more frequent checking for developing faults.

But it should be borne in mind that use of such pre-loaded devices very often means a great step-up in output due to the elimination of loading time formerly required for manual feeding each insert part to mould cavity.

Usual methods of presentation will also be observed, viz., illustrations will be given of selected and typical mould constructions embodying pre-loaders of several types, and all preferable and undesirable features noted, especially those coming within the sphere of activities of the maintenance toolmaker.

IN the previous section in this series the author devoted his attention to the important questions of insert location and proper retention within the mould cavity area, and numerous examples were given of different forms of construction which may be employed for obtaining those features with safety, economy and speed.

But another essential requirement in all forms of insert-type injection moulds is that of the rapid and correct feeding of the inserts to the mould cavity or cavities. Actually in the case, say, of a multi-impression mould with each impression having a number of insert components for moulding in position, it will be found that the greatest proportion of the moulding cycle is taken up by feeding the inserts into their correct positions. Such action will be still further aggravated and rendered more difficult and protracted if the inserts are of small dimensions, or have to be admitted to remote corners of the mould cavity, etc., or if purely manual application has to be made.

Preloading Type of Plate Feeder for Inserts

One of the most satisfactory and economical methods which can be employed with great success for overcoming the aforementioned feeding difficulties is that of the pre-loaded plate or similarly adapted fixtures. Particularly will use of such a type of insert feed facilitate operations where the shape of the insert renders its manual insertion into the mould difficult, or where a number of small-size insert components have to be dealt with in respect of each cavity.

Several substantial additional advantages also accrue from adoption of such a feeding method. They are:—

(1) As a general rule mould designs and constructions can usually follow the more simple line, thereby enabling the user to derive fullest benefits as regards increased production with little extra mould cost in comparison to a hand-fed mould, or a much more complicated design having fully automatic feed.

(2) Since such a pre-loaded plate is supplied with its necessary complement of insert components when removed from the mould, the operator is enabled to see clearly what he is doing, and complete access can also usually be furnished to each insert locating or housing point.

(3) Inserts of more complicated shape can often be used in conjunction with such a plate, and thus difficult moulding problems are often simplified when approached from this aspect.

(4) Because of their generally simple construction, maintenance service required for such moulds is very small, hence continuously long and accurate locating of inserts may confidently be anticipated.

(5) Very often a useful simplification of the mould construction, or the readier overcoming of some knotty design problem may be effected by embodying a portion of the mould cavity within such a pre-loading insert plate, and the possibilities of improved mould designs, smoother operation and simplified construction afforded by this single feature alone are innumerable.

(6) In those instances where inserts have to be very accurately located and positioned within the mould cavity the use of such a plate about to be described will often enable all difficulties to be overcome.

Several other lesser advantages could also be enumerated if space permitted, but it is hoped to indicate or at least mention them during the ensuing consideration of the illustrated example of a typical injection mould equipped for preloaded plate feeding of inserts.

Before beginning the study of this first mould example, a useful purpose will doubtless be served if consideration is given to some of the underlying general aims which a designer or mould engineer would seek to attain by the use of such a form of feeding device.

Usually he will strive to achieve at least three main objects when considering the selection, fashioning or improvization of mould mechanisms of this kind. Since these objectives may be regarded as constituting the chief desiderata common to injection moulds required for insert moulding, it will be advisable to spend a little time in briefly noting their relationship and importance. This, in fact, will be especially apposite as an introduction to this present section, since it is now proposed to deal with mould constructions and designs of a much more intricate character than any preceding.

First of all, then, semi or fully automatic methods for feeding inserts, or mechanisms ensuring more positive and accurate feeding of same will be desirable because of their wide and useful application to multi-impression moulds.

Secondly, the designer will be particularly concerned to ensure that any feeding, sorting or retaining mechanism installed shall be as rapid, simple and as near foolproof as possible.

Thirdly, it is equally important that any insert feeding mechanism, whether fully automatic or not, shall be of such a kind as will maintain the accurate location of the insert component throughout very long production runs. This is far more important than would appear at first sight because it involves a large number of considerations for effectively covering such points as wear and the means provided for correcting errors due to same. One frequently encounters moulds equipped with extraneous insert holding or feeding mechanisms which resemble nothing so much as a child's Meccano construction, and which are palpably deficient in robustness and strength to withstand the strains of prolonged service; rough handling at the hands of operators; or the hard usage usually attendant upon handling and storing.

One often feels that in numerous instances the provision of such insert feeding devices has been an after-thought on the part of the designer, made when the mould construction was far advanced, with the result that very inadequate means have had to suffice for the purpose. It is once again stressed very strongly that the greatest benefits possible from the use of such devices can only be gained when their design and construction are considered and incorporated with the general mould design from its inception.

Turning now to the first example which is shown at Fig. 1, this illustrates a typical type of preloading plate feeder for a number of inserts of different

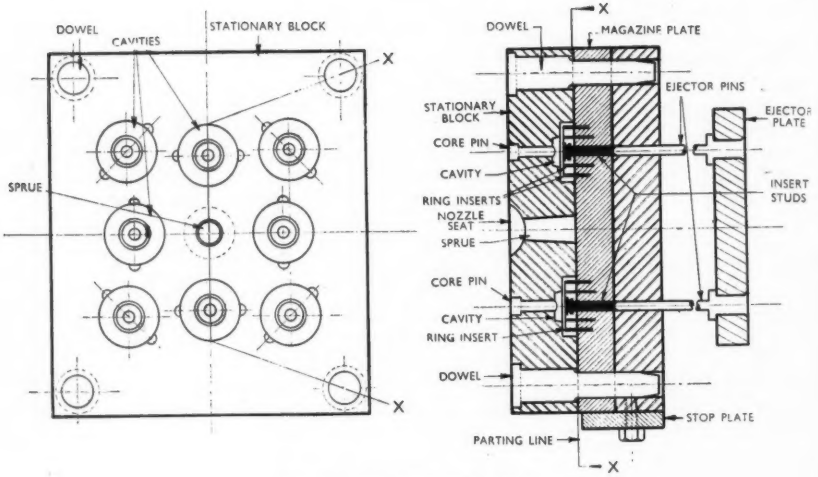

Fig. 1.—Section on line X X.

shapes and sizes as applied to a very common type of injection mould design.

The left-hand plan shows the parting-line surface of the stationary mould block only in order to indicate the contour and disposition of each of the eight cavities. This mould was designed for the production of a small circular-shaped component in cellulose acetate, and it will be noticed that the entire cavity portion is contained in the stationary block. One side (adjacent to parting-line) of the component is perfectly flat, the other having a small domed extension. Each finished article has two brass rings and a small-headed, plain, shanked brass stud moulded in place, as is shown by the fully sectioned view at the right.

This sectioned illustration is taken along the lines **X X** (see the left-hand figure), thereby passing through the two centre cavities, the sprue and two opposed corner dowels. In this moulded component it was important that the two brass ring inserts should be concentrically located with each other and also with the centrally positioned stud.

In this design the detachable insert feeder plate or magazine plate is interposed between the parting-line faces or the stationary and movable block members, as shown.

The seating for all three insert members in the case of each cavity are also provided in the left-hand face of this magazine plate and not in the face of the movable mould block as in the original design.

As will be seen, the four dowels for the alignment of the two mould blocks are situated permanently in the stationary block. The dowels are utilized for the correct location and retention of the detachable magazine feeder plate, this latter being drilled at the appropriate points so that the dowels can pass clean through the plate and into their guide holes machined in the movable block.

The magazine feeder plate is made equal in thickness to the distance the centre stud piece has to project from the finished moulded article for a reason which will be explained more clearly later when we come to describe the operation of this feeding device. The seatings cut in this plate for the brass ring should, of course, be made slightly larger to allow ready application of the components.

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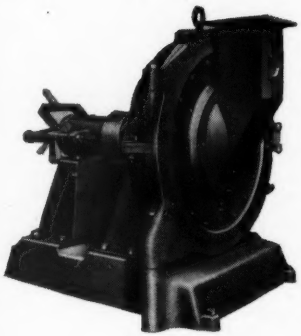

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To the bottom edge of the movable block is secured a stiff sectioned stop plate, as shown. This is required in order to facilitate the setting of the loaded magazine plate when the mould blocks are opened.

In actual operation of this mould, it should first be explained that three of these preloading magazine feed plates were made up, each being identical in all respects with the others. Provision had first to be made for the loading of the magazine plate prior to insertion into the mould. This was done by installing a suitable table or stand alongside the machine at which a girl operator worked in filling the two magazine plates not in use. When a shot had been completed the empty magazine plate was ejected from the machine, as will be described later, and passed directly to this operator, she, at the same time, giving a loaded plate to the machinist for insertion into position. The empty plate is then immediately cleaned up, briefly examined, and then loaded up again with its complement of insert members. Thus, loading, cleaning, etc., are carried on simultaneously with production.

Upon receiving a loaded magazine plate, the machine operator first observes whether the parting-line surface on the stationary mould block is perfectly clean, and, if so, drops the feeder plate approximately into position on the parting-line surface of the former, resting it upon the stop blade, as shown. The sides of the plate are then smartly lined up with outside edges of the block, and the latter then brought to closed position. Before reaching full closure, the dowels in the stationary block will pass through the magazine plate and into the other block, thereby bringing about correct alignment of the plate and true positioning of the inserts housed therein in relationship to the mould cavities.

The location of the centre-stud component insert into the magazine plate is greatly facilitated by making the plate the same thickness as the amount of stud projection, and previously mentioned. When loading these feed plates, the operator places them flat down on their rear faces, and thus the headed stud is simply dropped into position until its end contacts the table top underneath plate, thus correctly positioning it.

The finished moulded articles are ejected by means of pins bearing against the ends of these moulded-in studs, the ejector mechanism being contained in the movable mould block in normal manner.

After the moulding has been made, the mould blocks are opened in customary fashion, the magazine plate moving with the movable block, bringing with it the eight mouldings, which are easily withdrawn from their shallow cavities. This opening movement continues for a sufficient distance, whereupon the ejector plate bears against a stationary stop member on the machine bed. This results in any further opening travel of the movable block, causing the ejector pins to operate by passing through the magazine plate to strip off the finished moulding. The magazine plate the while rests upon the stop plate.

Notwithstanding the numerous advantages possessed by this type of magazine feed plate in the way of quicker feeding of the inserts and improved production from the mechanical standpoint of easy manipulation, wear resistance, maintained accuracy and general maintenance servicing, the construction leaves much to be desired, as will be appreciated from the following critical examination of the various aspects and features of the design.

Take first the matter of the thickness of the feeder plate. Obviously, there is a minimum thickness beyond which it will be inadvisable to go if distortion and warpage are to be obviated. In the case of very short components, this may lead to the provision of an excessively thin feeder plate, with harmful results. This plate should always be made substantial enough to maintain its surface flatness throughout the longest production runs for exposure to high temperatures.

Then in respect of the method of locat-

ing this magazine plate, i.e., by means of the four dowels, difficulties are almost certain to arise. Having to lead on the plate to engage with four dowels, each of which must be a close fit, a machine operator may have to indulge in considerable manipulation of the magazine plate by tapping it square on the four dowels so as to secure free engagement with same. Such actions will absorb considerable time and give rise to much irritation and delay.

No provision is made for maintaining the correct positioning of the magazine plate by the taking up of any wear occurring between the sides of the guide holes in plate and the dowels. If such wear is allowed to proceed unchecked, leading to an undue slackness of the magazine plate, serious misalignment of the respective inserts and their mould cavities may occur, caused by the offsetting of the plate with the stationary block. Indeed, costly errors and faulty mouldings may develop from this cause.

Should wear arise at these points, troubles would also be experienced in securing the proper and safe ejection of a finished spray of mouldings. Such difficulties would come about because the ejector pin holes in the movable mould block would tend to become out of line with the guide holes in the magazine plate in which are situated the headed stud inserts, along which holes the ejector pins have to pass when undergoing their ejection motions. Furthermore, if wear of this kind is permitted there will be much risk of causing damage or even complete fracture of the ejector pins themselves due to their failure to line up with the holes in the magazine plate.

Yet another drawback is to be found in the absence of any suitable handling or finger-gripping facilities on the magazine feeder plate. It will be seen that the overall dimensions of this member are made identical with those of the two mould blocks, so that when all three are in position their sides all match up evenly. This will entail the operator having difficulty in obtaining a sufficiently firm grip on the plate when setting or removing same from its position on the movable block. This will be particularly irksome to the user if the moulds have been allowed to run hot for a short period, as the magazine plate will then be similarly heated up and the operator will have to employ both hands to detach it from its seating or vice versa.

Again, since it is essential that the magazine feed plate shall move in unison with the movable block during the opening and closing motions of this latter member, such action is likely to be impeded because of the method of locating the mould dowels. These members it will be noted are fixedly secured to the stationary mould block. Hence when the movable members begin to move away from the stationary block the friction between the dowels and the guide holes in the magazine plate may cause the latter to hang back and thus to become mispositioned in relation to the movable mould half. Such sticking on the dowels may also result in distorted ejector pins, especially where these latter members are of slender dimensions.

A final objectionable feature worthy of careful notice is as follows. When the movable block has been withdrawn from the stationary mould block and the ejector pins have been operated to push out the finished moulding from the feeder plate, this latter member will then be hanging upon the extended ejector pins, and the operator will have to disengage this plate by sliding it off the projecting ejector pins. If these latter are of small diameter, damage may be caused to them during this action. Or if the magazine plate is very heavy and bulky its excessive weight may result in the same trouble.

These, then, are some of the chief constructional and operating disadvantages worthy of attention by the maintenance toolmaker especially, because it will be found in practice with such designs that it is precisely in respect of such points that his skilled services will generally be required.

To illustrate a number of very useful and inexpensive safeguards which may

easily be effected, a much improved design and method of construction of the same mould is shown in the fully sectioned assembled mould at Fig. 2.

This mould is for producing the same set of mouldings and moulded-in inserts as that depicted in Fig. 1, but the improved features are worthy of careful consideration.

Considering first the magazine feeder plate, this is made appreciably thicker in cross section thereby enabling it more effectively to withstand any distortion or warping influences. The headed stud inserts are consequently located well within the right-hand side face of the plate, and the ejector pins are correspondingly positioned within the plate for a short distance.

This latter provision overcomes the danger of the ends of ejector pins failing to engage correctly with the entrance to the holes in magazine plate during ejection. They also serve as additional means for locating the plate correctly, in relation both to the movable block and the mould cavities.

The magazine plate is also extended upwards beyond the top edge of the mould blocks as shown in order to provide greater gripping facilities. Two pins are secured in this extended portion and arranged so as to project each side of the plate, thus forming a convenient handle whereby the operator is able easily to take hold of the plate during removal or insertion into position. Incidentally such handle pegs may be made from a heat-insulating material such as fibre so that they remain relatively cool even if the mould is allowed to run too hot.

The dowels in this construction are permanently fixed to the movable block member as shown, whilst the guide holes through which they pass both in the magazine plate and the stationary mould block are suitably lined out with renewable hardened bushings or sleeves. These sleeves are a tight press fit within the sockets in the magazine plate and mould block, and of course positioned precisely in line and afterwards suitably lapped to ensure a smooth sliding fit of the various members, yet one free from any slackness. By positioning the dowels in the movable mould member several advantages are gained as follows:—

(a) The weight and strain of the magazine feeder plate are removed entirely from the ejector pins when these have been extended into their foremost position, thereby obviating any tendency to distort, bend, or damage same, because the plate never leaves the dowels before the ejectors have pushed out the finished mouldings. In point of fact, the operator will have to move the plate an appreciable distance over the dowels after this point

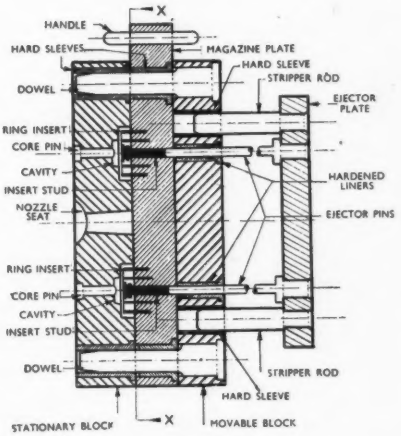

Fig. 2.

has been reached before the plate can be removed from the mould.

(b) The task of locating a freshly loaded insert plate is considerably eased since a greater access to the movable block when in its open position is usually obtainable.

(c) By locating the magazine plate on the movable block the operator will easily be able to tell at a glance whether all or any of the insert members have become displaced, as these will all be visible from the left-hand side of the plate before the mould blocks are closed. Compare this with the design described in Fig. 1, wherein the magazine plate has to be passed on to the dowels in the

stationary mould block. Should an insert part become moved from its correct position this will not be visible to the operator. This will mean that the moulds will have to be closed and then slightly opened again, at the same time bringing away the magazine feeder plate from the stationary block to ensure that the various inserts are properly located.

The ejector plate is provided with two stiff stripper rods as shown situated beyond the centres of the normal ejector pins. The rods are for the purpose of stripping off the magazine plate from the dowels, where such movement can conveniently be performed by the mechanical action of the mould block opening. The holes in which these stripper rods slide in the movable block are suitably lined out with hardened steel sleeves securely fixed therein, so that any developing wear can not only be kept at bay over much longer periods, but, when it does occur, can be readily and inexpensively corrected by the simple expedient of replacing the worn liners and dowels.

Similarly with respect to the ejector pins themselves, these are arranged so that they slide freely, but again without undue slackness within hardened liners fixed within the mould block. Here again the chief objective is elimination of wear and its resultant misalignment.

This is a much preferred form of design and construction requiring normally a maintenance service of very small extent. Such as it will entail will comprise a regularized inspection service for the detection of signs of wear between the dowels and their guide sleeves; ejector pins and sleeves, etc.; the maintaining of the magazine feeder plate perfectly flat and free from all distortion, warpage and surface bruises due to handling, exposure to excessive heat and pressure influences and the like. Some care will have to be exercised by the loaders of these plates to ensure that the surface finish is not marred by too severe dropping on to hard surfaces such as the table top upon which loading operations have to be performed. These plates will have to be handled with great care. They should, of course, be of steel hardened and surface ground.

The hardened sleeves within the mould blocks and magazine plate, etc., should preferably be of the headed type and so located that the head portion takes the main thrust or frictional resistance as is clearly shown in the illustration. If this is not watched carefully troubles may ensue as a result of a headless liner becoming slightly displaced from its correct setting and having as a result one end-face slightly projecting beyond the end-face of the plate or block, as the case may be. Should this occur the parting-line surfaces of the mould blocks with the magazine plate will fail to seal properly leading first to the formation of excessive flash around the finished moulded article, and if persistent the more serious difficulties of stiffened working of mould members and their eventual seizure or even complete fracture due to heavy strains imposed.

Yet another essential point to be closely regarded by the observant maintenance engineer and also the machine operator concerns mould cleanliness. Actually a mould of the type just illustrated and described may be regarded as having two parting-line surfaces because of the interposition of the magazine feed plate.

Hence it is imperative that the operator take especial pains to ensure that all these faces are maintained clear of adhering particles of dirt, oil, or excess plastic material. Unless this factor is impressed upon the machine operator it may be found that damage develops in respect of the ejector pins, their guide holes, or to the magazine plate itself due to the clamping up of the mould blocks whilst foreign substances lodge between essential faces.

Some attention will also have to be devoted to the condition of the insert seating recesses and the stud insert guide hole in the magazine plates. Some wear will inevitably take place here, particularly at the entrance to these holes, they will tend to become somewhat bell-mouthed. This condition may not be serious in itself, but it is usually the precursor of more troublesome conditions

because in time the resulting excess flash around the finish moulding will tend to travel within the insert seatings and to effect a binding action upon the free withdrawal of same during ejection. Thus the ejection movements will become increased in stiffness and finally the studs or rings may seize up within their seatings sufficiently to cause bending or breakage of the ejectors; or, again, the ejector pin holes may become badly torn, or bruised out of shape.

As a method of ensuring the rapid assembly of a large number of inserts of simple and regular shape such as those already instanced, and in cases where the bulk of the mould cavity can be located in one mould block, this simple type of magazine preloading plate will prove admirably suitable, and, given reasonable care and skill in its manufacture, should give consistently sound service without much maintenance attention being required.

An Alternative Type of Preloading Magazine Plate Design

In Fig. 3 a plan and a sectional view are shown of another type of preloading magazine plate the design and construction of which will prove of interest.

Here again this mould is eight impression type, the moulded article consisting of a headed knob-like part having a short cylindrical and parallel shank portion around the exterior of which a steel ring has to be moulded as shown. Also up the centre a shouldered and threaded stud has to be moulded in situ, this stud having a square head for more effective keying into the plastic material.

This construction employs a parallel preloading magazine plate substantially of the kind used in the mould previously dealt with.

It should also be specially noted that a portion of the mould cavity is machined in the left-hand side face of the magazine plate, this being, of course, made large enough to receive the ring insert member.

In this case the magazine plate is not located on the four mould dowels as in the previous instance, instead, the parting-line face of the stationary mould block is recessed out to form a wide parallel gap having dead square sides as shown at A and B respectively in the left-hand plan view. Into this recess is fitted a free sliding fit, the magazine plate. Vertical location in relation to the mould cavities is secured by means of the stop plate at bottom edge of the stationary block as

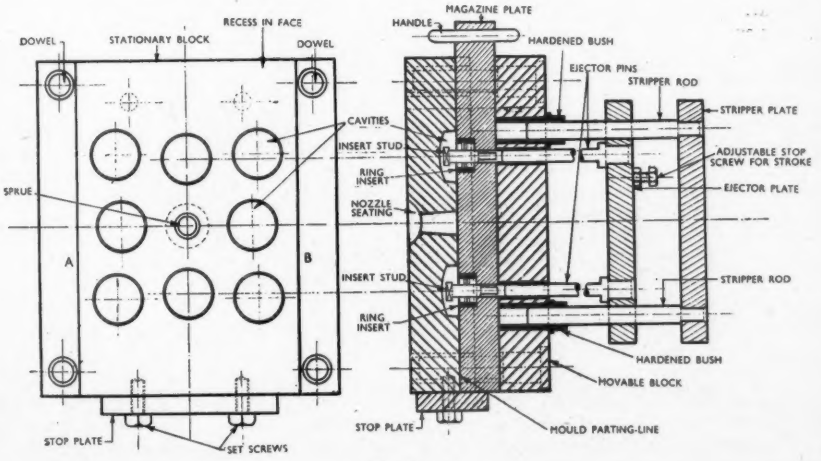

Fig. 3.

indicated. The magazine plate rests upon this plate when the mould cavities are correctly in line. The top end of the plate extends well beyond the top edges of the mould blocks and is fitted with handles of insulating material as before.

This construction employs a duplex ejection mechanism as shown. The other stripper plate is secured to four equally spaced stripper rods each of ample cross-sectional area. These rods are made a sliding fit within the movable mould block and their inner end faces contact against the right-hand side of the magazine plate between the blocks.

The ejector plate is arranged to slide freely along the four stripper rods, and has secured to it the requisite number of ejector pins, which latter pass through hardened steel liners secured within the movable block.

The action of this duplex ejection arrangement is as follows. The movable block, when undergoing its opening motion, takes with it the magazine plate, together with all the moulded articles, which latter parts are withdrawn from the mould cavity in stationary block as the other half moves away. The magazine plate and movable block continue a predetermined distance, whereupon the further movement of the stripper plate is arrested by contact with a fixed member on the machine frame. As the mould continues to open beyond this point the stripper plate is closed inwards, thus causing the stripper rods to pass down their guide holes in mould block. Before the stripper rods make contact with the magazine plate, however, the stripper plate bears against the ejector plate proper, communicating to this member its motion which serves to eject the finished mouldings from the shallow cavity formed in the magazine plate, before the latter is stripped from the blocks.

Another very useful provision in respect to the ejection system on this mould construction is that three adjustable set screws are screwed through the ejector plate, situated so as to project from its right-hand side as shown. These screws are capable of being locked to ejector plate in any desired position so far as projection is concerned. The stripper plate makes contact with the heads of these screws instead of against the flat face of the ejector plate.

The practical advantages of this arrangement will readily be apparent. Thus, by previously setting these screws so as to have a predetermined amount of projection (which must be exactly the same in the case of all three screws, of course, if the stripper plate is perfectly flat), the timing of the commencement of the moulding ejection stroke proper can be controlled and varied within specified limits.

In cases where it is not possible to have a stripper plate of uniform section, use of set screws in this manner will enable the mould engineer to ensure that the stripper plate makes contact with the ejector plate simultaneously at the essential points. This will enable him to avoid any twisting, tilting, or distorting tendencies which might otherwise arise between these two plates.

Better bearing contact is also secured between the two members, and since the plates do not actually come close together throughout their entire surfaces, there is no danger of material, tools, or other extraneous articles becoming trapped between when the ejection stroke is being performed.

It will also be specially noted that this mould is equipped with a stop plate secured to the bottom edge of the stationary block as in the previous examples. It fulfils exactly the same purpose also, viz., to facilitate the correct positioning of the pre-loaded magazine plate whilst the mould is being loaded.

Actual loading of this type of mould simply consists of inserting the pre-loaded magazine plate within the parallel recess in the parting-line surface of the stationary block, allowing the bottom edge of the plate to rest upon the stop plate. If this bottom edge is machined up dead square with the sides the plate will stand firmly and in close contact with the block whilst the mould is closed.

(To be continued)

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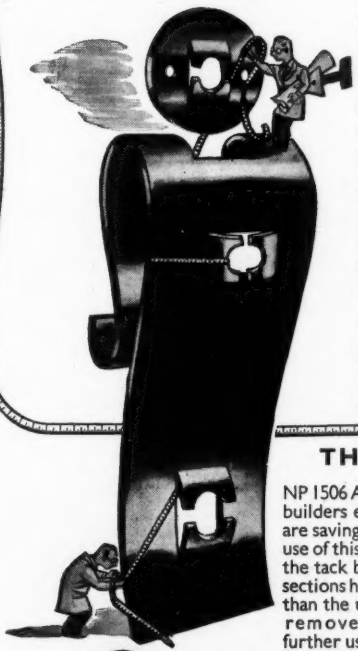

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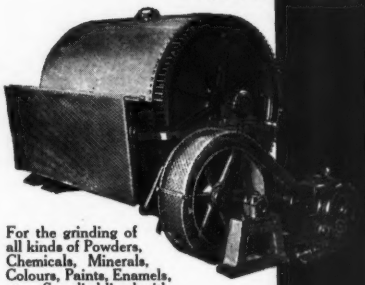

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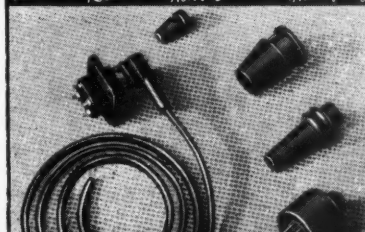

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Advertiser (London), specialized in packaging, closure, display and kindred materials, active and enterprising, many years' successful sales record with excellent home and export outlets, wishes to discuss sales agency arrangements with manufacturers, etc. Box 7471, care of "Plastics." 101-x2380

Important Egyptian manufacturer of plastic material, with sound connection throughout Orient and Middle East, desires to contact British plastics manufacturers and die makers with a view to representation in these areas. Box 7860, care of "Plastics." 103-4855

Manufacturers of exclusive lines, interested in New Zealand post-war markets, are offered services of live, up-to-date manufacturers' representatives and agents. Engineering Alliance, Ltd., Consulting and Efficiency Engineers, agents to the Engineering and Allied Trades. Temporary British address: 11 Albion Avenue, Stanley Park, Blackpool. 101-x3228

Efficient sales organization in British India, with branches and distributors in all important cities and a staff of 125 travelling representatives, is interested in representing manufacturers of chemicals, patent medicines, patent foods, surgical and hospital requirements, laboratory equipment, rubber goods, plastics, refrigerators, paints and varnishes. Please apply by air mail to: The Sales Manager, Standard Pharmaceutical Works, Ltd., 67 Dr. Suresh Sarkar Road, Entally, Calcutta (British India). 101-9

Representative with sound connection South Coast desires plastic agencies. Box 63, Smiths, Square, Bournemouth. 101-14

BOOKS AND PUBLICATIONS

"Plastics Catalogs" for 1945, 1944, 1943. Excellent condition; will separate. Offers to Box 7372, care of "Plastics." 101-x2134

FINANCIAL AND PARTNERSHIP

Firm of Importers and Exporters would take financial interest in injection moulding concern. Write, Box 3283, Frost-Smith Advtg., 64 Finsbury Pavement, E.C.2. 102-4644

MACHINERY, TOOLS AND PLANT

Two 15-punch Worssam rotary tableting machines, two Manesty No. 3 single-punch tableting machines, excellent condition, all motorized 400/3/50, seen working. Write Box F 705, care of Jackson's, 16 Gracechurch St., E.C.3. 101-16

Machinery, Tools and Plant Wanted

Injection Moulding Machine wanted up to 2-oz. capacity. Box 7854, care of "Plastics." 101-19

OFFICES, BUSINESSES, PREMISES, ETC.—Wanted

Suite of Offices required in Birmingham by old-established business concern. Full particulars to D., Box 7864, care of "Plastics." 101-1

PRODUCTION CAPACITY AVAILABLE AND WANTED

Draughtsmen specializing in design of injection, transfer, compression moulds and all types of jigs and fixtures have capacity available immediately. All inquiries receive prompt attention. Box 7538, care of "Plastics." 101-x2571

Manufacturing Company, N.E. London, have surplus capacity and full facilities for carrying out the assembly of moulded plastic products. Write in first instance to Box 7871, care of "Plastics." 103-4854

Rubber Moulders have immediate capacity. Inquiries invited. Box 7853, care of "Plastics." 101-18

SITUATIONS VACANT

None of the vacancies under this heading relates to a man between the ages of 18 and 50 inclusive or a woman between 18 and 40 inclusive unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.

Manager, storekeeper and order clerk wanted for plastic and photographic material business. Lloyd's, 72 Bridge Street, Christchurch. zzz-49

Draughtsman-Designer wanted. First-class man with complete knowledge of plastic moulding tools, excellent opportunity for the right man, good prospects. Write, stating full details of experience and salary required, to Box 7324, care of "Plastics." 102-4617

Wanted, young graduate chemist as assistant to plant superintendent; knowledge of colour matching or plastics an advantage. Apply Box 7869, care of "Plastics." 101-5

Draughtsman required with knowledge of mould design. Apply, stating age, experience, etc., to Box 7867, care of "Plastics." 101-8

Toolmaker required by small firm in Essex, must possess first-class practical experience in the production of plastic moulding tools; permanent progressive position with excellent prospects. Apply, giving full particulars of past experience and wages required, to Box 7537, care of "Plastics." 103-x2572

Assistant required, preferably under 30, in sales office of important plastics manufacturers; knowledge of the chemistry of plastics would be an advantage. State full particulars of previous experience and salary required. Box 7868, care of "Plastics." 101-6

Engraving and Dyeing. Men or women skilled in either or both required in progressive plastics factory. Apply, stating age, experience, etc., to Box 7866, care of "Plastics." 101-7

Craftsman with experience in the forming and cementing of Perspex and cellulose plastics required by large concern situate in the Home Counties. Write, giving age, experience, etc., Box 7861, care of "Plastics." 101-13

Maintenance Engineer required for plastic factory, London area. Please write, giving full details past experience, etc., to Box H.K. 7862, care of "Plastics." 101-12

Manufacturers' Agents for all types of plastic materials and fabricated goods require reliable salesmen to represent them on a commission basis in all parts of the British Isles. Full particulars to Belvane, Ltd., 101 Old Winton Road, Andover, Hants. 103-4857

Scandinavian Industrial Concern wants an experienced engineer possessing a practical background of several years, able to start and supervise a plant manufacturing plastics for different purposes. Apply to Box 7859, care of "Plastics." 101-15

Experienced synthetic resin adhesives representative required by old-established plastics manufacturers near London, excellent salary and commission, permanent appointment with prospects of advancement. Box 7855, care of "Plastics." 103-4860

SITUATIONS WANTED

Young Man, 25, single, wishes to better position. 11 years in plastics industry, experienced in mould design and all types of moulding, eight years in toolroom, first-class bench hand, machinist and Keller diesinker operator, capable of organizing, good education, willing to travel anywhere, present salary £450 p.a. Box 7434, care of "Plastics." 101-x2276

Advertiser, able to take charge complete plastic plant installation, development and maintenance, long satisfactory service with leading firm, desires change where ability will be acknowledged. Box 7462, care of "Plastics." 101-x2332

Plastics Technician (thermosetting), young, energetic, desires change. Ten years' practical and technical experience, including development, testing, production and tool design. Situation must be progressive. Position abroad considered. Box 7787, care of "Plastics." 101-x3256

Thermoplastic mouldings. Engineer (41), 15 years' experience all phases production, mould, jig and tool design, seeks position with scope works or production manager. Reply to Box 7587, care of "Plastics." 101-x2731

Plastics Engineer (34) desires change, preferably as project or development engineer. Qualifications include B.Sc. (Mech. Eng., 1st Class Hons.), M.Sc., City and Guilds—Plastics (1st Class Pass), shipyard (2-year) and plastic moulding (1-year) apprenticeships. Experience of injection, compression and transfer moulding of thermosetting and thermoplastic resins, also of full processing of laminations, including wood, tool and moulding design experience. Minimum salary £900. Box 7613, care of "Plastics." 101-x2826

Rubber Technologist, with extensive experience in dispersion processes, natural and synthetic latices and their application in industry, desires to change present position for one of wide scope and high responsibility in production or research. Box 7614, care of "Plastics." 101-x2825

Situations Wanted—*contd.*

Radio Frequency Development Engineer, 11 years' experience transmitters, oscillators, desires contact plastic moulders or similar manufacturer; H.F. heating application, equipment design. Box 7439, care of "Plastics." 101-x2308

Tool and Mould Maker requires position as manager or toolroom foreman, 14 years' practical experience, used to costing and own designing. Box 7657, care of "Plastics." 101-x2940

WANTED

Acetate and Nitrate. Sheet off-cuts and scrap plastic materials of every description wanted. We can arrange collection. Top prices paid. Lloyd's, 72 Bridge Street, Christchurch, Hants. Phone, Christchurch 504. zzz-51

Wanted, large quantity of Handles (similar to child's skipping-rope handle). Would consider rejected material or surplus parts, suitably shaped. Write Pratt and Sons, Woodbridge Street, E.C.1. 101-4422

Wholesalers wish to contact manufacturers of plastic goods for domestic use. Frigonia, Ltd., 10-12 Copthall Avenue, London, E.C.2. 102-4604

Urea Powder, small or large quantities, any colour, required for export moulding orders. Box 7269, care of "Plastics." 102-4603

Merchants with established wholesale connection require mouldings of own design. Tools supplied if necessary. Write, Box 3285, Frost Smith Advtg., 64 Finsbury Pavement, E.C.2. 102-4645

P.V.C. Sheeting required, all colours, large or small quantities. Offers to Box 7865, care of "Plastics." 101-10

London Wholesalers, serving 300 shops (not obsessed by export business), requires supplies of coloured and white tea cups, saucers, egg cups, ashtrays and allied plastic goods. Continuing business assured. Box 7853, care of "Plastics." 103-4856

Wanted, injection moulding equipment for the manufacture of tooth brush, shaving brush, other brush handles and other allied articles. Also automatic and semi-automatic brush-making machinery for a brush-making firm in South India. Box 7857, care of "Plastics." 101-11

Celluloid or cellulose acetate tubes, approximately 1/8 in. by 1/16 in., required. Continuous orders given. Box 7858, care of "Plastics." 101-17

Urea and phenol moulding powder, in all colours, urgently wanted. Box 7856, care of "Plastics." 102-4859

MISCELLANEOUS

400-Ton Vertical 4-Column 4-Daylight Upstroke Hydraulic Press by Shaw, ram 16-in. dia. by 30-in. stroke, maximum daylight 48-in. working pressure on ram 2·3 tons per sq. in., 5-in. dia. columns, complete with five new steel steam-heated plattens, 72 ins. by 51 ins.

535-Ton Vertical 4-Column Hydraulic Press by Shaw, ram 18-in dia. by 54-in. stroke, maximum daylight 6½-ft. working pressure on ram 2½ tons per sq. in., table 72-in. by 48-in., columns 7-in. dia. (two available).

400-Ton Vertical 4-Column 15-Daylight Upstroke Hydraulic Press by Rose, Downs and Thompson, ram 16-in. dia. by 26-in. stroke, 6-in. dia. columns, working pressure 2 tons per sq. in., complete with steel plattens 35 in. by 24-in. by ½-in. thick.

50-Ton Vertical 4-Column Upstroke Hydraulic Press by Planters Eng. Co., ram 8-in. dia., side return rams 1½-in. dia., complete with two thermostatically controlled electrically heated mild steel plattens, Fraser Mono-Radial Pump and 3 h.p. motor 400 volts 3-phase 50 cycles, all new 1945.

Harland Multi-stage Low-pressure Hydraulic Pump, direct coupled to 175 b.h.p., Harland motor 400 volts 3-phase 50 cycles 2,950 r.p.m. with starter, 4-in suction and delivery, capacity 300 g.p.m. at 500 lb pressure, new 1942.

Vertical 6-Throw Hydraulic Pump by Mills, rams 2½-in., 2-in. and 1½-in. dia. by 6-in. stroke, mounted on tank bed and vee rope driven by 25 h.p. B.T.H. slip ring motor, 400-volt 3-phase 50 cycles, 960 r.p.m., with starter, working pressure 2 tons per sq. in.

Horizontal 4-Throw Hydraulic Pump by Planters Eng. Co., rams 2¼-in., 1⅝-in., 1⅛-in. dia. by 2½-in. stroke, mounted on tank bed, vee rope driven from 8 h.p. Brook motor, 400 volts 3-phase 50 cycles, with starter, 2 tons per sq. in. pressure, new 1942.

Newman Industries, Ltd., Yate, Bristol. 103-4853

Factory Time Recorders. Service rental. Phone, Vigilant 4731. Time Recorder, Supply and Maintenance Co., 28 Mayfield Road, Sutton, Surrey. 101-3531

Impregnation and coating of fabrics and papers. Also cutting and reeling, all expertly done by The "Transproof" Paper Co., Purley Way, Croydon. Phone, Croydon 6157. 104-3954

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Moulds. Grained embossing plates and rollers. J. Martin and Sons, Ltd., Ardwick, Manchester, 12. 110-4421

Manufacturers! Idea for new bathroom gadget (patented), suit plastics-rubber. Write, Box 7461, care of "Plastics." 101-x2324

Crystal Acetate, approximately 4 cwt. of 2 mm., crystal acetate in sheets, for sale. Box 7870, care of "Plastics." 101-4

Pulverizing and Grading. Reduction of most thermoplastics down to 200 mesh undertaken by Dohm, Ltd., 167 Victoria Street, London, S.W.1. 108-4533

Sir William Crawford and Partners, Ltd., Industrial Designers, undertake design and styling of new products or machines. Working prototypes made if required. 233 High Holborn, W.C.1. Phone, Holborn 4381. zzz-50

Engindex. New directory, bibliography and information service for mechanical and civil engineers. Fully comprehensive, always up to date. Send stamp for full particulars. BCM/Engindex, London, W.C.1. 102-x1232

New Electric Motors for immediate delivery, 1 h.p. to 5 h.p., 400/440 volts, 3-phase, 50 cycles, by best makers. No licence. The Sterling Pump Co., Ltd., Spalding. 103-4858

The Carbon-Silicon Co., P.O. Box 4138, Johannesburg, wish to contact manufacturers of plastic materials, moulding powders, machinery and chemicals, suitable for household building and engineering plastic products. Interested also in silicon, boron, and inorganic binders and coatings. 101-2

Plastic Paint Powder and Crystals (patented) for producing finest resin-bound water-paint. Exceptional post-war demand expected for home and foreign trade. Firms desiring to manufacture under licence, write "Plastics," Pearce's Advertising Agency, Merchant Street, Bristol 1. 101-3

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